PETERSON RANCH

Buffalo Canyon Feeders CAFO Project

Design Report

July 2020

Prepared by:

GreatWest engineering®

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Background

This design report in conjunction with the construction plans are intended to demonstrate to the Montana DEQ that the proposed facility meets the design criteria for Concentrated Animal Feeding Operations. More information on the details of the project including the Nutrient Management Plan are included in the DEQ FACTS database submittal.

Stormwater Ponds

The CAFO is divided into two separate operational areas called the North and South. Each operational area has its own stormwater pond which meets Montana DEQ standards. Sizing calculations are summarized below. Ponds are equipped with 1 foot freeboard and 1 foot residual storage volume which are not included in the design capacity volumes.

South Stormwater Pond

Drainage Area = 16.5 Acres

25 year- 24 hour rain event = 2.6" - See Figure 2B in Attachment A

Soils are Clay Loam – See Attachment B for Soils Information - Use Run-off Curve Number 89 for poor hydrogeologic condition – conservative

Run-off from Design Event = 1.5" – See Attachment A

- 25 year – 24 hour Run-off Event Volume = 89,800 cubic feet
- Normal Run-off During Storage Period – See Attachment A for Judith Gap average precipitation over 180 storage period of October through March. To be conservative run-off was estimate as occurring in one event of 3.6 inches which results in runoff depth of 2.5 inches. Normal Run-off Volume = 140,300 cubic feet
- Rain on Pond during 25 year 24 hour run-off event. Pond area = 2.3 acres. Rain on Pond Volume from design event = 22,000 cubic feet.
- Normal rain on pond during storage period is 3.6 inches. However, normal evaporation from pond from October and March will exceed 3.6 inches for this site. See attachment A for statewide evaporation data. Therefore no additional volume for this criteria.
- Total storage volume required = 252,100 cubic feet
- Total design capacity south stormwater pond = 263,700 cubic feet

North Stormwater Pond

Drainage Area = 7.4 Acres

25 year- 24 hour rain event = 2.6" - See Figure 2B in Attachment A

Soils are Clay Loam – See Attachment B for Soils Information - Use Run-off Curve Number 89 for poor hydrogeologic condition – conservative

Run-off from Design Event = 1.5" – See Attachment A

- 25 year – 24 hour Run-off Event Volume = 40,500 cubic feet.
- Normal Run-off During Storage Period – See Attachment A for Judith Gap average precipitation over 180 storage period of October through March. To be conservative run-off was estimate as occurring in one event of 3.6 inches which results in runoff depth of 2.5 inches. Normal Run-off Volume = 63,300 cubic feet.
- Rain on Pond during 25 year 24 hour run-off event. Pond area = 1.7 acres. Rain on Pond Volume from design event = 15,700 cubic feet.
- Normal rain on pond during storage period is 3.6 inches. However, normal evaporation from pond from October and March will exceed 3.6 inches for this site. See attachment A for statewide evaporation data. Therefore, no additional volume for this criteria.
- Total storage volume required = 119,500 cubic feet
- Total design capacity south stormwater pond = 126,800 cubic feet

Liner, Earthwork and Vent system specifications are included in Attachment C.

Groundwater Well and Lagoon Setback Criteria

There are three groundwater wells which are located within the 1,000 foot setback to liquid waste impoundments outlined in ARM 17.30.1702. Under section (3)(d) of the law the setback can be reduced to 100 feet, if the applicant can demonstrate that there is no hydraulic connection between the sewage lagoon and the water well. The existing hydrogeologic information demonstrates that the existing water supplies cannot be contaminated by leakage from the new animal waste lagoons.

The new lagoons will lined with a synthetic 60 mil HDPE liner system installed on top of a liner subgrade constructed of native clay loams. This will provide an excellent composite lining system for the lagoons that will have minimal leakage. Technical drawings and specifications for the liner system are attached in Attachment C.

On site surface soils consist of clay loams and silty clay loams. This was confirmed by the excavation of five test pits in the project area. Test pits revealed a mantle of 3-6 feet of native clay material underlain by a water bearing zone of sandy gravel. Groundwater was

encountered at a depth of 4 to 7 below the ground surface and had 1-2' of confining pressure which would allow the groundwater to rise up in the pit after the excavation. This shallow groundwater flows to the north/northeast based on groundwater elevation data collected during the field investigation. This shallow groundwater likely discharges to Ross Fork Creek based on the topography and groundwater data collected. In the event of leakage from the waste impoundments this shallow groundwater will be impacted. This groundwater is not utilized on the project site or the either of the two sections north of the applicant's property according to the GWIC database.

There are three wells within the 1,000 foot setback of the ponds. The first well identified a GWCI ID 266587 is owned by the applicant and a well log is included in Attachment D. This well is 2003 feet deep and is completed in the Kootenai formation. The water bearing zone is located between 1950 and 2000 feet. The well flows as an artesian well. Therefore, this water bearing zone has over 1950 feet of confining pressure. There are multiple layers of shale and siltstone which provide the confining pressure and protection of the aquifer. This well is in section 2 located approximately 900 feet west from the south stormwater pond.

The second well is also an artersian well identified as GWIC ID 177767 and a well log is included in Appendix D. This well is offset 240 feet west of the north stormwater pond. The well is 165 feet deep and completed in fractured gray shale between 55 feet to 100 feet. This well has flowed continuously in recent years. This water bearing zone has over 55 feet of confining pressure. The combination of the confining pressure and low permeability shale and clay layers provide significant natural protection of the groundwater.

he origin of the third well is unknown. It may be GWIC ID 24415 which is included in the Appendix. This well is not used anymore and will be abandoned in accordance with State Law.

The combination of the confining pressure and low permeability aquitard units between the groundwater surface will prevent contamination of usable groundwater in the area from the wastewater lagoons. In addition, if any leakage occurs from the waste ponds only the shallow groundwater which is not used will be impacted.

Environmental Investigations

The facility footprint was examined to make sure that no wetlands or floodplains will be impacted as a result of the project. A technical memorandum addressing these issues is included in Attachment E. The technical memorandum concludes that neither the floodplain or wetlands will be impacted as a result of the project. The project area has been used as a farm and ranch operation for many years and the entire footprint of the project has been previously disturbed by farming and ranching activities.

Attachment A
Hydrologic Data

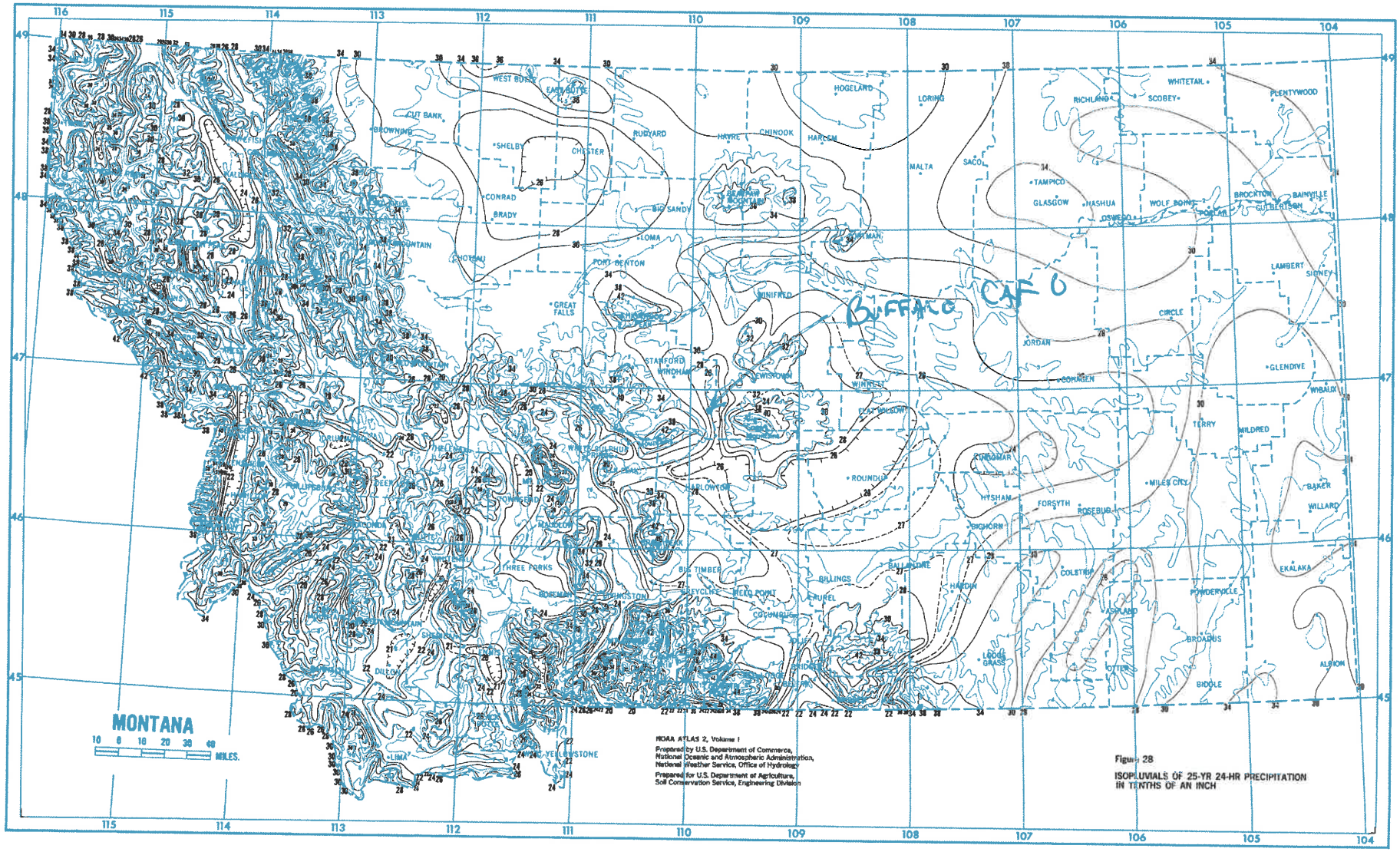
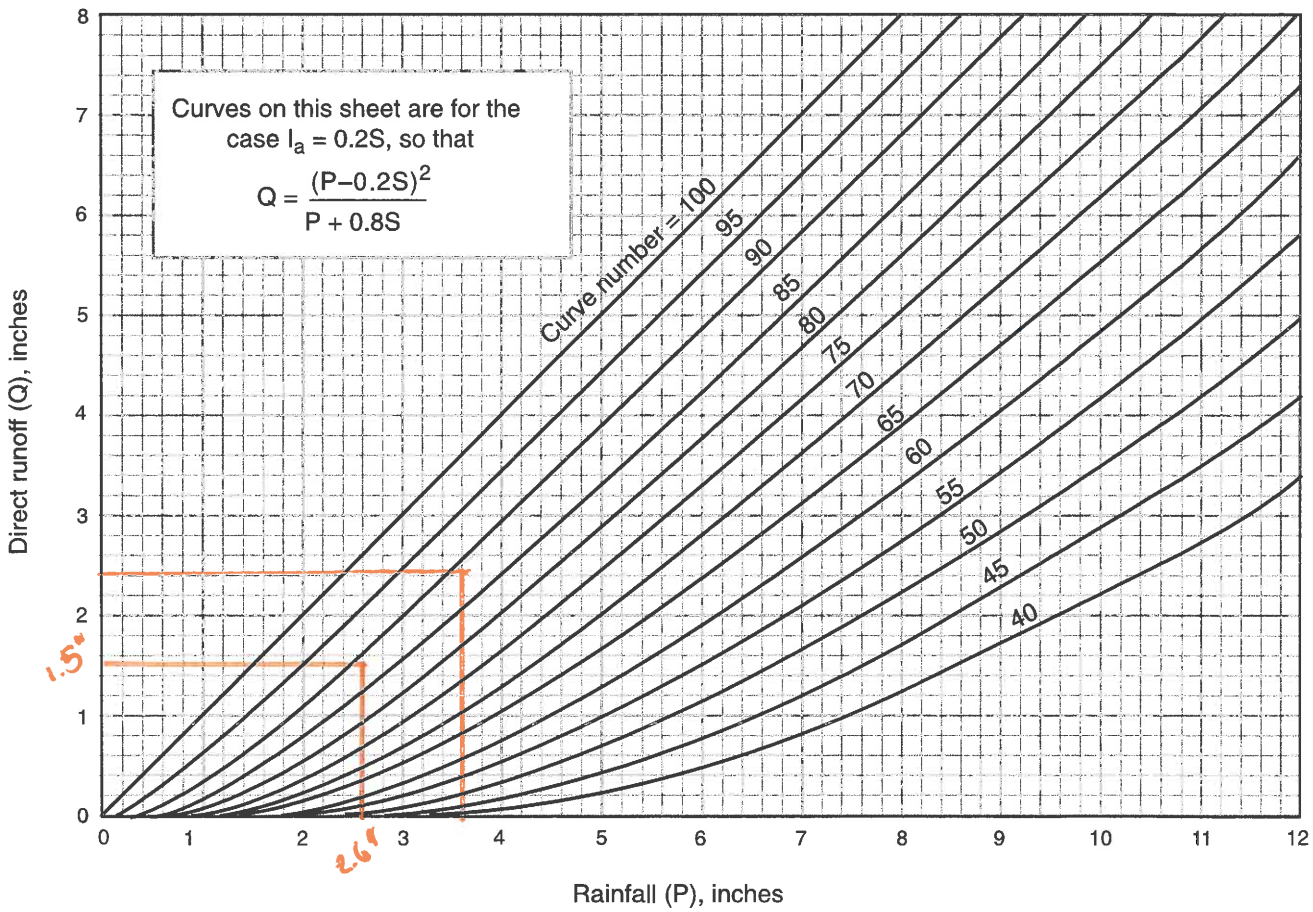

MONTANA
10 0 10 20 30 40
MILES.
NOAA ATLAS 2, Volume I
Prepared by U.S. Department of Commerce,
National Oceanic and Atmospheric Administration,
National Weather Service, Office of Hydrology
Prepared for U.S. Department of Agriculture,
Soil Conservation Service, Engineering Division
Figure 28
ISOPLUVIALS OF 25-YR 24-HR PRECIPITATION
IN TENTHS OF AN INCH

Figure 2-1 Solution of runoff equation.



Cover type

Table 2-2 addresses most cover types, such as vegetation, bare soil, and impervious surfaces. There are a number of methods for determining cover type. The most common are field reconnaissance, aerial photographs, and land use maps.

Treatment

Treatment is a cover type modifier (used only in table 2-2b) to describe the management of cultivated agricultural lands. It includes mechanical practices, such as contouring and terracing, and management practices, such as crop rotations and reduced or no tillage.

Hydrologic condition

Hydrologic condition indicates the effects of cover type and treatment on infiltration and runoff and is generally estimated from density of plant and residue cover on sample areas. ***Good*** hydrologic condition indicates that the soil usually has a low runoff potential for that specific hydrologic soil group, cover type, and treatment. Some factors to consider in estimating the effect of cover on infiltration and runoff are (a) canopy or density of lawns, crops, or other vegetative areas; (b) amount of year-round cover; (c) amount of grass or close-seeded legumes in rotations; (d) percent of residue cover; and (e) degree of surface roughness.

Table 2-2a Runoff curve numbers for urban areas [1]

Cover description		Curve numbers for hydrologic soil group			
Cover type and hydrologic condition	Average percent impervious area [2]	A	B	C	D
Fully developed urban areas (vegetation established)					
Open space (lawns, parks, golf courses, cemeteries, etc.) [3]:					
Poor condition (grass cover < 50%)		68	79	86	89
Fair condition (grass cover 50% to 75%)		49	69	79	84
Good condition (grass cover > 75%)		39	61	74	80
Impervious areas:					
Paved parking lots, roofs, driveways, etc. (excluding right-of-way)		98	98	98	98
Streets and roads:					
Paved; curbs and storm sewers (excluding right-of-way)		98	98	98	98
Paved; open ditches (including right-of-way)		83	89	92	93
Gravel (including right-of-way)		76	85	89	91
Dirt (including right-of-way)		72	82	87	89
Western desert urban areas:					
Natural desert landscaping (pervious areas only) [4]		63	77	85	88
Artificial desert landscaping (impervious weed barrier, desert shrub with 1- to 2-inch sand or gravel mulch and basin borders)		96	96	96	96
Urban districts:					
Commercial and business	85	89	92	94	95
Industrial	72	81	88	91	93
Residential districts by average lot size:					
1/8 acre or less (town houses)	65	77	85	90	92
1/4 acre	38	61	75	83	87
1/3 acre	30	57	72	81	86
1/2 acre	25	54	70	80	85
1 acre	20	51	68	79	84
2 acres	12	46	65	77	82
Developing urban areas					
Newly graded areas (pervious areas only, no vegetation) [5]		77	86	91	94
Idie lands (CN's are determined using cover types similar to those in table 2-2c).					

1 Average runoff condition, and I_a = 0.2S.

2 The average percent impervious area shown was used to develop the composite CN's. Other assumptions are as follows: impervious areas are directly connected to the drainage system, impervious areas have a CN of 98, and pervious areas are considered equivalent to open space in good hydrologic condition. CN's for other combinations of conditions may be computed using figure 2-3 or 2-4.

3 CN's shown are equivalent to those of pasture. Composite CN's may be computed for other combinations of open space cover type.

4 Composite CN's for natural desert landscaping should be computed using figures 2-3 or 2-4 based on the impervious area percentage (CN = 98) and the pervious area CN. The pervious area CN's are assumed equivalent to desert shrub in poor hydrologic condition.

5 Composite CN's to use for the design of temporary measures during grading and construction should be computed using figure 2-3 or 2-4 based on the degree of development (impervious area percentage) and the CN's for the newly graded pervious areas.

Table 2-2b Runoff curve numbers for cultivated agricultural lands [1/]

Cover description			Curve numbers for hydrologic soil group			
Cover type	Treatment [2/]	Hydrologic condition [3/]	A	B	C	D
Fallow	Bare soil	—	77	86	91	94
	Crop residue cover (CR)	Poor	76	85	90	93
		Good	74	83	88	90
Row crops	Straight row (SR)	Poor	72	81	88	91
		Good	67	78	85	89
	SR + CR	Poor	71	80	87	90
		Good	64	75	82	85
	Contoured (C)	Poor	70	79	84	88
		Good	65	75	82	86
	C + CR	Poor	69	78	83	87
		Good	64	74	81	85
	Contoured & terraced (C&T)	Poor	66	74	80	82
		Good	62	71	78	81
	C&T+ CR	Poor	65	73	79	81
		Good	61	70	77	80
Small grain	SR	Poor	65	76	84	88
		Good	63	75	83	87
	SR + CR	Poor	64	75	83	86
		Good	60	72	80	84
	C	Poor	63	74	82	85
		Good	61	73	81	84
	C + CR	Poor	62	73	81	84
		Good	60	72	80	83
	C&T	Poor	61	72	79	82
		Good	59	70	78	81
	C&T+ CR	Poor	60	71	78	81
		Good	58	69	77	80
Close-seeded or broadcast legumes or rotation meadow	SR	Poor	66	77	85	89
		Good	58	72	81	85
	C	Poor	64	75	83	85
		Good	55	69	78	83
	C&T	Poor	63	73	80	83
		Good	51	67	76	80

1 Average runoff condition, and I_a=0.2S

2 Crop residue cover applies only if residue is on at least 5% of the surface throughout the year.

3 Hydraulic condition is based on combination factors that affect infiltration and runoff, including (a) density and canopy of vegetative areas, (b) amount of year-round cover, (c) amount of grass or close-seeded legumes, (d) percent of residue cover on the land surface (good ≥ 20%), and (e) degree of surface roughness.

Poor: Factors impair infiltration and tend to increase runoff.

Good: Factors encourage average and better than average infiltration and tend to decrease runoff.

Table 2-2c Runoff curve numbers for other agricultural lands [1/]

Cover description		Curve numbers for hydrologic soil group			
Cover type	Hydrologic condition	A	B	C	D
Pasture, grassland, or range—continuous forage for grazing. [2/]	Poor	68	79	86	89
	Fair	49	69	79	84
	Good	39	61	74	80
Meadow—continuous grass, protected from grazing and generally mowed for hay.	—	30	58	71	78
Brush—brush-weed-grass mixture with brush the major element. [3/]	Poor	48	67	77	83
	Fair	35	56	70	77
	Good	30 [4/]	48	65	73
Woods—grass combination (orchard or tree farm). [5/]	Poor	57	73	82	86
	Fair	43	65	76	82
	Good	32	58	72	79
Woods. [6/]	Poor	45	66	77	83
	Fair	36	60	73	79
	Good	30 [4/]	55	70	77
Farmsteads—buildings, lanes, driveways, and surrounding lots.	—	59	74	82	86

1 Average runoff condition, and $I_a = 0.2S$.

2 ***Poor:*** <50%) ground cover or heavily grazed with no mulch.
Fair: 50 to 75% ground cover and not heavily grazed.
Good: > 75% ground cover and lightly or only occasionally grazed.

3 ***Poor:*** <50% ground cover.
Fair: 50 to 75% ground cover.
Good: >75% ground cover.

4 Actual curve number is less than 30; use CN = 30 for runoff computations.

5 CN's shown were computed for areas with 50% woods and 50% grass (pasture) cover. Other combinations of conditions may be computed from the CN's for woods and pasture.

6 ***Poor:*** Forest litter, small trees, and brush are destroyed by heavy grazing or regular burning.
Fair: Woods are grazed but not burned, and some forest litter covers the soil.
Good: Woods are protected from grazing, and litter and brush adequately cover the soil.

Table 2-2d Runoff curve numbers for arid and semiarid rangelands [1]

Cover description		Curve numbers for hydrologic soil group			
Cover type	Hydrologic condition [2]	A [3]	B	C	D
Herbaceous—mixture of grass, weeds, and low-growing brush, with brush the minor element.	Poor		80	87	93
	Fair		71	81	89
	Good		62	74	85
Oak-aspen—mountain brush mixture of oak brush, aspen, mountain mahogany, bitter brush, maple, and other brush.	Poor		66	74	79
	Fair		48	57	63
	Good		30	41	48
Pinyon-juniper—pinyon, juniper, or both; grass understory.	Poor		75	85	89
	Fair		58	73	80
	Good		41	61	71
Sagebrush with grass understory.	Poor		67	80	85
	Fair		51	63	70
	Good		35	47	55
Desert shrub—major plants include saltbush, greasewood, creosotebush, blackbrush, bursage, palo verde, mesquite, and cactus.	Poor	63	77	85	88
	Fair	55	72	81	86
	Good	49	68	79	84

1 Average runoff condition, and I_a = 0.2S. For range in humid regions, use table 2-2c.
2 Poor: <30% ground cover (litter, grass, and brush overstory).
Fair: 30 to 70% ground cover.
Good: > 70% ground cover.
3 Curve numbers for group A have been developed only for desert shrub.

Back to:

State Map | Western U.S. map | Home Page

NOTE:
To print data frame (right side), click on right frame before printing.

1981 - 2010

- Daily Temp. & Precip.
- Daily Tabular data (~23 KB)
- Monthly Tabular data (~1 KB)
- NCDC 1981-2010 Normals (~3 KB)

1971 - 2000

- Daily Temp. & Precip.
- Daily Tabular data (~23 KB)
- Monthly Tabular data (~1 KB)
- NCDC 1971-2000 Normals (~3

JUDITH GAP, MONTANA (244538)

Period of Record Monthly Climate Summary

Period of Record : 7/ 1/1950 to 12/31/2005

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Average Max. Temperature (F)	37.7	38.4	44.3	56.0	63.7	71.3	86.4	83.6	72.0	58.8	44.9	37.1
Average Min. Temperature (F)	15.9	14.1	19.6	29.6	35.5	43.9	52.6	50.1	40.8	31.3	22.0	15.2
Average Total Precipitation	0.66	0.47	0.74	1.21	2.70	3.00	1.84	1.56	1.15	0.76	0.48	0.49

TOTAL NORMAL PRECIP OCT-MAR = 3.6"
TO BE CONSERVATIVE CALC RUN-OFF 2.5" RUN-OFF
AS ONE EVENT CN=89

BABB 6 NE	1948-2005	0.00	0.00	0.00	0.00	5.23	5.91	6.87	5.90	4.06	0.00	0.00	0.00	27.97
BOZEMAN MONTANA ST UNIV	1892-2005	0.00	0.00	0.00	3.34	5.58	6.03	8.34	7.17	4.57	2.62	0.00	0.00	37.65
BOZEMAN 6 W EXP FARM	1966-2005	0.00	0.00	0.00	4.24	5.68	6.62	8.19	7.73	4.88	2.99	0.00	0.00	40.33
CANYON FERRY DAM	1948-1957	0.00	0.00	0.00	0.00	7.98	7.13	8.17	7.41	5.50	3.11	0.00	0.00	39.30
CANYON FERRY DAM	1907-1996	0.00	0.00	0.00	3.15	5.04	6.21	7.91	7.04	4.18	1.93	0.00	0.00	35.46
DILLON WMCE	1895-2005	0.00	0.00	0.00	3.05	4.72	5.32	6.41	5.45	3.48	2.84	0.00	0.00	31.27
FORT ASSINNIBOINE	1917-2005	0.00	0.00	0.00	4.54	6.43	7.30	8.86	8.12	5.00	0.00	0.00	0.00	40.25
FORT PECK	1948-1956	0.00	0.00	0.00	0.00	5.99	8.17	9.51	8.04	5.36	4.25	0.00	0.00	41.32
FORT PECK POWER PLANT	1956-2005	0.00	0.00	0.00	0.00	7.34	8.45	10.42	9.81	5.83	3.53	0.00	0.00	45.38
HUNGRY HORSE DAM	1948-2005	0.00	0.00	0.00	0.00	4.83	5.62	7.81	6.63	3.46	1.37	0.00	0.00	29.72
HUNTLEY EXPERIMENT STN	1911-2005	0.00	0.00	0.00	5.03	6.71	7.40	8.88	8.15	5.10	0.00	0.00	0.00	41.27
LONESOME LAKE	1948-1981	0.00	0.00	0.00	0.00	7.42	7.60	9.25	8.31	5.70	0.00	0.00	0.00	38.28
MALTA 7 E	1972-2005	0.00	0.00	0.00	4.67	6.50	6.51	7.61	6.84	4.17	1.34	0.00	0.00	37.64
MEDICINE LAKE 3 SE	1911-2005	0.00	0.00	0.00	0.00	7.44	7.69	9.62	9.19	5.36	0.00	0.00	0.00	39.30
MOCCASIN EXPERIMENT STN	1909-2005	0.00	0.00	0.00	4.35	6.59	7.72	9.66	9.21	6.39	0.00	0.00	0.00	43.92
SIDNEY	1910-2005	0.00	0.00	0.00	3.99	5.63	6.44	6.93	5.45	2.89	1.81	0.00	0.00	33.14
TIBER DAM	1952-2005	0.00	0.00	0.00	0.00	4.51	6.46	7.65	5.56	4.34	0.00	0.00	0.00	28.52
VALIER	1911-2005	0.00	0.00	0.00	0.00	5.37	6.49	7.33	5.62	4.72	0.00	0.00	0.00	29.53
WESTERN AG RESEARCH CNT	1965-2005	0.00	0.00	0.00	0.00	5.08	6.03	7.26	6.07	4.14	2.25	0.00	0.00	30.83
YELLOWTAIL DAM	1948-2005	0.00	0.00	0.00	0.00	6.94	8.84	10.60	9.74	6.58	4.86	0.00	0.00	47.56

NEVADA

MONTHLY AVERAGE PAN EVAPORATION (INCHES)

	PERIOD OF RECORD	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
BEOWAWE U OF N RANCH	1972-2005	0.00	0.00	0.00	3.98	7.17	8.68	10.42	9.52	6.97	4.43	0.00	0.00	51.17
BOULDER CITY	1931-2004	3.71	4.68	7.56	10.67	13.79	16.57	16.45	14.41	11.51	8.11	4.87	3.69	116.02
CALIENTE	1928-2005	0.00	0.00	3.97	6.82	8.57	10.58	11.13	9.41	6.89	4.35	1.91	0.00	63.63
CENTRAL NEVADA FIELD LA	1965-1986	0.00	0.00	2.98	5.95	8.69	10.49	12.24	11.31	8.08	4.88	1.73	0.00	66.35
FALLON EXPERIMENT STN	1950-2005	1.34	2.23	4.39	6.15	7.66	8.83	9.81	8.55	6.05	3.89	2.29	1.34	62.43
LAHONTAN	1948-2005	0.00	0.00	0.00	7.18	9.64	11.58	13.75	12.23	7.83	4.51	2.09	0.00	68.81
LOGANDALE	1968-1992	2.55	3.61	5.26	8.96	12.44	14.20	14.38	12.07	8.67	7.66	3.86	2.89	96.55
RUBY LAKE	1948-2005	0.00	0.00	0.00	5.10	7.09	8.90	10.54	9.37	6.51	3.95	0.00	0.00	51.46
RYE PATCH DAM	1948-2005	0.00	0.00	3.71	5.83	7.38	9.23	11.15	10.06	6.95	4.30	0.77	0.00	59.38
SILVERPEAK	1967-2005	0.00	3.84	7.26	10.13	13.60	16.31	17.98	15.92	11.32	6.88	2.94	0.00	106.18
TOPAZ LAKE	1957-2005	0.00	0.00	0.00	7.15	9.11	10.94	12.68	11.56	8.80	5.95	2.79	0.00	68.98

Attachment B
Soils Data

Soil Map—Fergus County, Montana, and Judith Basin Area, Montana
(Peterson Ranch)

Map Scale: 1:11,900 if printed on A landscape (11" x 8.5") sheet.

N

Meters: 0 150 300 600 900

Feet: 0 500 1000 2000 3000

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 12N WGS84

MAP LEGEND

Area of Interest (AOI)
- Area of Interest (AOI)

Soils
- Soil Map Unit Polygons
- Soil Map Unit Lines
- Soil Map Unit Points

Special Point Features
- Blowout
- Borrow Pit
- Clay Spot
- Closed Depression
- Gravel Pit
- Gravelly Spot
- Landfill
- Lava Flow
- Marsh or swamp
- Mine or Quarry
- Miscellaneous Water
- Perennial Water
- Rock Outcrop
- Saline Spot
- Sandy Spot
- Severely Eroded Spot
- Sinkhole
- Slide or Slip
- Sodic Spot
- Spoil Area
- Stony Spot
- Very Stony Spot
- Wet Spot
- Other
- Special Line Features

Water Features
- Streams and Canals

Transportation
- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

Background
- Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at scales ranging from 1:20,000 to 1:24,000.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Fergus County, Montana
Survey Area Data: Version 20, Sep 16, 2019

Soil Survey Area: Judith Basin Area, Montana
Survey Area Data: Version 15, Sep 16, 2019

Your area of interest (AOI) includes more than one soil survey area. These survey areas may have been mapped at different scales, with a different land use in mind, at different times, or at different levels of detail. This may result in map unit symbols, soil properties, and interpretations that do not completely agree across soil survey area boundaries.

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Aug 28, 2014—Nov 7, 2016

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Map Unit Legend

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
53	Daglum-Adger complex, 0 to 2 percent slopes	5.8	1.0%
105	Fluvaquentic Haplaquolls, nearly level	105.4	17.4%
129	Judith-Judell clay loams, 2 to 4 percent slopes	1.9	0.3%
130	Judith-Tamaneen clay loams, 0 to 2 percent slopes	146.3	24.2%
133	Judith-Windham gravelly clay loams, 2 to 8 percent slopes	11.4	1.9%
145	Lawther silty clay, 0 to 2 percent slopes	27.1	4.5%
151	Linwell silty clay loam, 0 to 2 percent slopes	171.5	28.3%
197	Savage silty clay loam, 0 to 2 percent slopes	75.2	12.4%
210	Straw clay loam, 0 to 2 percent slopes	37.9	6.3%
272	Winifred-Judith clay loams, 4 to 8 percent slopes	6.9	1.1%
Subtotals for Soil Survey Area		**589.2**	**97.3%**
Totals for Area of Interest		**605.4**	**100.0%**

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
Sx	Straw clay loam, 2 to 4 percent slopes	16.1	2.7%
Subtotals for Soil Survey Area		**16.1**	**2.7%**
Totals for Area of Interest		**605.4**	**100.0%**

Attachment C

Construction Drawings and Technical Specifications

SECTION 02320

LAGOON EARTHWORK

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, Division 1 Specification Sections and Special Provisions apply to this Section.

1.2 SUMMARY

A. This Section includes the following:
   1. New lagoon excavation, embankment, compaction and grading.
   2. Geomembrane liner subgrade preparation and grading.
   3. Backfill and compaction of geomembrane liner anchor trench.
   4. Excavation and embankment for lagoon structures.

B. Related Sections include the following:
   1. Division 2 Section "Site Clearing" for temporary erosion and sedimentation control measures, site stripping, grubbing, stripping and stockpiling topsoil, and removal of above- and below-grade improvements and utilities.
   2. Division 2 Section 02221 "Trench Excavation and Backfill for Pipelines & Appurtenant Structures.
   3. Division 2 Section 02644 "60 mil Textured HDPE Liner"

1.3 DEFINITIONS

A. Borrow Soil: Satisfactory soil imported from off-site for use as fill or backfill.

B. Excavation: Removal of material encountered above subgrade elevations and to lines and dimensions indicated.

C. Embankment and Fill: Soil materials used to raise existing grades.

D. Native Soil: Soil material that is in-place or excavated from the project site.

E. Rock: Rock material in beds, ledges, unstratified masses, conglomerate deposits, and boulders of rock material 1 cubic yard or more in volume that exceed a standard penetration resistance of 100 blows/2 inches when tested by an independent geotechnical testing agency, according to ASTM D 1586.

F. Structures: Buildings, footings, foundations, retaining walls, slabs, tanks, curbs, mechanical and electrical appurtenances, or other man-made stationary features constructed above or below the ground surface.

G. Subgrade: Surface or elevation remaining after completing excavation, or top surface of a fill or backfill immediately below subbase, drainage fill, or topsoil materials.

H. Utilities: On-site underground pipes, conduits, ducts, and cables, as well as underground services within buildings.

1.4 SUBMITTALS

A. Material Test Reports: From a qualified testing agency indicating and interpreting test results for compliance of the following with requirements indicated:
   1. Classification according to ASTM D 2487 of each on-site and borrow soil material proposed for fill and backfill.
   2. Laboratory compaction curve according to ASTM D 698 for each on-site and borrow soil material proposed for fill and backfill.

B. When, in the opinion of the Engineer, the field soil conditions differ from those represented by the material test reports, new samples shall be taken by the Contractor and delivered to the testing agency for classification and laboratory compaction curve testing. All testing shall be based on the appropriate soil test results.

1.5 QUALITY ASSURANCE

A. Geotechnical Testing Agency Qualifications: An independent testing agency qualified according to ASTM E 329 to conduct soil materials and rock-definition testing, as documented according to ASTM D 3740 and ASTM E 548.

Field Survey and Construction Tolerances: The Contractor will provide horizontal and vertical control for earthwork. The Contractor shall provide all additional surveys for line, grade and structural location.

1.6 PROJECT CONDITIONS

A. Based on a test pits at the site, adequate quantities of soil materials meeting the general embankment and liner subgrade specification will be encountered during excavation for the new lagoons.

B. If materials meeting the liner subgrade specification are encountered in-place in lagoon excavations, the liner subgrade can be compacted in-place.

C. Where unsuitable liner subgrade soil materials are encountered in the excavations, they will be subexcavated to a depth of six inches (6") and replaced with material meeting the liner subgrade specification.

PART 2 - PRODUCTS

2.1 GENERAL.

A. Provide borrow soil materials when sufficient satisfactory soil materials are not available from excavations.

2.2 SOIL MATERIALS

A. Satisfactory lagoon dike material:
   1. On-site soil material free of rock or gravel larger than 8 inches (75 mm)] in any dimension, debris, waste, frozen materials, vegetation, and other deleterious matter.
   2. Borrow soil material meeting ASTM D 2487 Soil Classification Groups GW, GP, GM, SW, SP, CL, ML, and SM or a combination of these groups; free of rock or gravel larger than 6 inches in any dimension, debris, waste, frozen materials, vegetation, and other deleterious matter.

B. Unsatisfactory Soils: Saturated fine-grained materials are unsatisfactory.

C. Unsatisfactory soils include satisfactory soils not maintained within 2 percent of optimum moisture content at time of compaction.

D. Liner Subgrade: In-place native or borrow soil material naturally or artificially graded mixture of soil with 100 percent passing a 1/2 inch sieve and 40 percent passing a No. 200 Sieve.

PART 3 - EXECUTION

3.1 GENERAL

A. Take precautions to protect all adjoining private and public property and facilities, including underground and overhead utilities, access roads, structures, and fences. Restore or replace all disturbed or damaged facilities to their original condition at Contractor's expense.

B. Preparation of subgrade for earthwork operations including removal of vegetation, topsoil, debris, obstructions, and deleterious materials from ground surface is specified in Division 2 Section "Site Clearing."

C. Protect and maintain erosion and sedimentation controls, which are specified in Division 2 Section "Site Clearing," during earthwork operations.

D. Contact utility owners using the Montana One Call System for utility locates at least 48 hours before staring work. Protect utilities exposed during the work and prevent damage to underground utilities adjacent to excavations. Immediately notify the utility owner of any construction damage. Repairs of damage to marked utilities are at the expense of the Contractor.

E. Protect existing site improvements from damage during construction. Restore damaged improvements to their original condition, as acceptable to Owner.

F. Prior to beginning excavation, backfilling, and grading operations, perform all necessary surveys for control of line and grade and establish firm and protected monuments for reference throughout the construction period. Provide a sufficient number of such monuments throughout the work to permit verification of the work within the tolerances specified. Protect and maintain benchmarks and survey control points from disturbance during construction.

G. The methods of construction will be the Contractor's responsibility. Utilize equipment appropriate for the work being performed and assure all methods and equipment used result in finished work meeting the construction tolerances specified.

H. No work may be performed beyond the construction limits without prior written approval from the adjoining landowner.

3.2 DEWATERING

A. Prevent surface water and ground water from entering excavations, from ponding on prepared subgrades, and from flooding Project site and surrounding area.

B. Protect subgrades from softening, undermining, washout, and damage by rain or water accumulation.
   1. Reroute surface water runoff away from excavated areas. Do not allow water to accumulate in excavations. Do not use excavated trenches as temporary drainage ditches.
   2. If required, install a dewatering system to keep subgrades dry and convey ground water away from excavations. Maintain until dewatering is no longer required.

3.3 EXPLOSIVES

A. Explosives: Do not use explosives.

3.4 EXCAVATION

A. Excavate to subgrade elevations regardless of the character of surface and subsurface conditions encountered. Excavated materials may include soil materials, and obstructions.
   1. If excavated materials intended for fill and backfill include unsatisfactory soil materials and rock, replace with satisfactory soil materials.

3.5 EXCAVATION FOR LAGOON STRUCTURES

A. Excavate to indicated elevations and dimensions within a tolerance of plus or minus 1 inch (25 mm). If applicable, extend excavations a sufficient distance from structures for placing and removing concrete formwork, for installing services and other construction, and for inspections.
   1. Excavations for Footings and Foundations: Do not disturb bottom of excavation. Excavate by hand to final grade just before placing concrete reinforcement. Trim bottoms to required lines and grades to leave solid base to receive other work.
   2. Excavation for Lagoon Structures: Excavate to elevations and dimensions indicated within a tolerance of plus or minus 1 inch (25 mm). Do not disturb bottom of excavations intended as bearing surfaces.

3.6 LINER SUBGRADE

A. Notify Engineer when excavations have reached required liner subgrade.

B. If Engineer determines that unsatisfactory liner subgrade soil material is present, subexcavate to a depth of six inches (6") and replaced with material meeting the liner subgrade specification.

C. Liner subgrade may be constructed of material excavated from on-site or from borrow areas.

D. All interior side slopes and lagoon pond bottoms require soil material meeting the liner subgrade specification.

E. The liner subgrade shall be graded uniformly smooth and be free from angular rocks, roots and vegetation.

F. Reconstruct subgrades damaged by freezing temperatures, frost, rain, accumulated water, or construction activities, as directed by Engineer, without additional compensation.

3.7 STORAGE OF SOIL MATERIALS

A. Stockpile borrow soil materials and excavated satisfactory soil materials without intermixing. Place, grade, and shape stockpiles to drain surface water. Cover to prevent windblown dust.
   1. Stockpile soil materials away from edge of excavations. Do not store within drip line of remaining trees.

3.8 EMBANKMENT

A. Embankments may be constructed of material excavated from on-site or from identified borrow areas. Use material free of cinders, ash, refuse, organic or frozen material, boulders, or other deleterious materials.

3.9 SOIL MOISTURE CONTROL

A. Uniformly moisten or aerate subgrade and each subsequent fill or backfill soil layer before compaction to within 3 percent of optimum moisture content.
   1. Do not place backfill or fill soil material on surfaces that are muddy, frozen, or contain frost or ice.
   2. Remove and replace, or scarify and air dry otherwise satisfactory soil material that exceeds optimum moisture content by 2 percent and is too wet to compact to specified dry unit weight.

3.10 COMPACTION OF SOIL EMBANKMENTS AND FILLS

A. Place backfill and fill soil materials in layers not more than 8 inches (200 mm)] in loose depth for material compacted by heavy compaction equipment, and not more than 4 inches (100 mm) in loose depth for material compacted by hand-operated tampers.

B. Complete compaction entirely across each layer of embankment and/or subgrade, commencing at the sides and progressing toward the center, overlapping each preceding pass by approximately one-half the width of the compaction equipment.

C. Suspend and modify compaction as required whenever evidence of pumping or unconsolidation of underlying work is observed.

D. Control the operation of compaction equipment to prevent damage to previously completed work including adjacent structures, pipelines, and previously completed layers of embankment

E. Place backfill and fill soil materials evenly on all sides of structures to required elevations, and uniformly along the full length of each structure.

F. Place and compact soil materials as follows to not less than the following percentages of maximum dry unit weight according to ASTM D 698:
   1. Embankment
      a. Place embankment backfill in maximum 8 inch (20 cm) compacted lifts within 3 percent of optimum moisture content and compact to a minimum of 95 percent.
   2. Liner Subgrade
      a. If native soils are encountered during excavation meeting the specification for liner subgrade, leave the material undisturbed. If disturbed, compact material to a minimum of 95 percent.
      b. Place imported liner subgrade backfill in one 6 inch (20 cm) lift
      c. Compact to a minimum of 95 percent.
   3. Pipe Trenches in Embankment
      a. Do not bed pipe placed within lagoon embankments with Type 1 Bedding. Use embankment material free of organic debris and deleterious material and containing no rocks greater than one inch (2.5 cm) in any dimension to carefully bed pipe placed in the embankment.
      b. Place trench backfill in maximum 8 inch (20 cm) compacted lifts within 3 percent of optimum moisture content and compact to a minimum of 95 percent.

3.11 TOPSOIL

A. Place stockpiled topsoil to a depth of 6 inches (15 cm) on the exterior dikes of the new pond construction, pipe excavations, and all disturbed areas except access roads, streets, and alleys. Stockpile excess topsoil in a location approved by the Engineer.

3.12 GRADING

A. General: Uniformly grade areas to a smooth surface, free of irregular surface changes. Comply with compaction requirements and grade to cross sections, lines, and elevations indicated.
   1. Provide a smooth transition between adjacent existing grades and new grades.
   2. Cut out soft spots, fill low spots, and trim high spots to comply with required surface tolerances.

B. Site Grading: Slope grades to direct water away from buildings and to prevent ponding. Finish subgrades to required elevations within the following tolerances:

3.13 CLEANUP AND DISPOSAL

A. As work progresses, remove debris and complete to finish grade each portion of the work. Once the work is complete, finish the entire site to a smooth, uniform surface presenting a neat and workmanlike appearance.

B. Remove all vegetation, debris, concrete, large boulders, and other undesirable material from the site and legally dispose of them. Remove and dispose of all rocks brought to the surface during excavation or backfilling.

END OF SECTION

SECTION 02625

GEOSYNTHETIC DRAINAGE FLOWNET COMPOSITE

PART 1 - GENERAL

1.1 DESCRIPTION

A. This work shall consist of furnishing and installing the drainage flownet composite in 10-inch strips as a venting layer below the HDPE liner in the lagoon cells as shown on the plans.

1.2 SUBMITTALS

A. Furnish the following information to the Engineer prior to installation.

B. Installation layout drawings. Submit drawings showing proposed panel layout. These drawings shall be approved prior to installing the flownet. This approval will be for concept only and actual panel placement will be determined by site conditions.

C. Statements of experience from the proposed flownet supplier and installer.

D. Installer's geosynthetic Field Installation Quality Assurance Plan.

E. Samples of flownet proposed for use on project.

F. Results of conformance testing specified within Paragraph 1.4 of this section.

G. Results of shear testing specification within Paragraph 1.3 of this section.

H. The Contractor shall submit a notarized manufacturer's certification that the material meets the specifications in this section.

I. The Contractor shall submit the following for each roll of material.
   1. Manufacturer's name
   2. Product identification
   3. Lot number
   4. Roll number
   5. Roll dimensions

1.3 CONFORMANCE TESTING

A. The Engineer will sample flownet materials which have arrived on-site for conformance testing. The Contractor will be responsible for forwarding conformance samples to a certified, third party, testing laboratory for testing. Conformance samples will be taken a minimum of each lot or every 100,000 square feet of material whichever results in more tests. Flownet samples will be tested for peel strength and in-place flow rate. Samples will be tested to insure conformance with the specifications.

B. No flownet material shall be installed until conformance testing is complete on that material and results show that the delivered material meets the requirements of the specifications. Material which fails to meet the requirements of the conformance testing shall be rejected and not utilized within the project. Rejected material will be replaced with material meeting the specifications at no additional cost to the Owner. The Contractor shall pay for all costs associated with this conformance testing and retesting of new material, if necessary.

PART 2 - MATERIALS

2.1 GENERAL

A. The drainage flownet shall be a bonded composite of HDPE drainage net with a layer of nonwoven geotextile factory-bonded to both sides.

B. The geocomposite shall be manufactured by heat bonding the geotextile(s) to the HDPE drainage net. No burn through geotextiles shall be permitted. No glue or adhesive shall be permitted.

C. The bond between the geotextile and the HDPE drainage net shall exhibit minimum average peel strength of 2 lbs. per inch as per ASTMD-413.

D. The manufacturer shall submit samples of the HDPE drainage net and geotextile to the engineer with a complete set of specifications for approval. The manufacturer shall also furnish a complete set of written instructions for storage, handling, installation, and joining.

E. The composite shall have a minimum transmissivity (ASTM D4716-87) of 2 gal/min/ft at gradient = 0.1 and pressure = 14.5 psi.

F. The nonwoven geotextile(s) shall have a minimum fabric weight (ASTMD 3776) of 6 oz/sq.yd.

PART 3 - INSTALLATION

3.1 GENERAL

A. The HDPE surface shall be cleaned of soil materials prior to deployment of the flownet. Care shall be taken to keep the geocomposite clean and free from debris prior to installation. If geocomposite is not free of soil and debris before installation, it shall be cleaned by the contractor just prior to installation.

B. On slopes, the geocomposite shall be placed in strips between the liner and finish subgrade as shown in the Drawings.

C. Adjacent rolls shall be overlapped approximately 2-4 inches and secured by plastic ties. Plastic ties shall be white or another bright color for easy inspection. Metallic ties shall not be allowed. The unbonded edge of the geotextile will then be either overlapped, sewn, or heat tacked per the manufacturer's recommendations. The geocomposite shall not be welded to geomembranes.

D. In the corners of the side slopes, where overlaps between rolls of geocomposite are staggered, an extra layer of geocomposite shall be installed from the top to the bottom of the slope.

E. The installer shall handle all geocomposite rolls in such a manner as to ensure they are not damaged in any way, and the following shall be complied with:
   1. The geocomposite shall be placed on all side slopes as shown on the contract drawings. The geocomposite shall be secured in the anchor trench and then rolled down the slope over the textured HDPE in such a manner to continually keep the geocomposite in tension, If necessary, the geocomposite shall be positioned by hand after being unrolled to minimize wrinkles. The geocomposite can not be placed in the horizontal direction (i.e., across the slope).

F. In the presence of wind, all geocomposite rolls in place shall be weighted with sandbags or the equivalent. Such sandbags shall be installed during placement and shall remain until replaced with cover material.

G. Contractor shall place all cover materials in such a manner as to ensure the geocomposite and underlying materials are not damaged.

END OF SECTION

SECTION 02644

60 MIL HDPE FLEXIBLE MEMBRANE LINER

PART 1 - GENERAL

1.1 DESCRIPTION

A. The work shall consist of providing all materials, tools, equipment and labor necessary to install the geomembrane to the lines and grades shown in the drawings. The work includes preparation of the surface to receive the geomembrane, excavation and backfilling of the anchor trenches, installation of the geomembrane material complete with seams, and other appurtenances. The work shall include field testing and sampling of seams and providing the necessary testing and sampling equipment. The landfill cell will be lined with double-side textured 60 mil HDPE.

1.2 REFERENCES

A. Geosynthetic Research Institute (GRI) Standards
   1. GRI Test Method GM13, Test Methods, Test Properties and Testing Frequency for High Density Polyethylene (HDPE) Smooth and Textured Geomembranes
   2. GRI Test Method GM19, Seam Strength and Related Properties of Thermally Bonded Polyolefin Geomembranes
   3. GRI Test Method GM29, Field Integrity Evaluation of Geomembrane Seams (and Sheet) Using Destructive and Nondestructive Testing

B. American Society for Testing and Materials (ASTM)
   1. D 638 Standard Test Method for Tensile Properties of Plastic
   2. D 698 Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort
   3. D 792 Standard Test Method for Density and Specific Gravity (Relative Density) of Plastics by Displacement
   4. D 1004 Standard Test Method for Tear Resistance (Graves Tear) of Plastic Film and Sheeting
   5. D 1238 Standard Test Method for Flow Rates of Thermoplastics by Extrusion Plastometer
   6. D 1505 Standard Test Method for Density of Plastics by the Density-Gradient Technique
   7. D 1603 Standard Test Method for Carbon Black Content in Olefin Plastics
   8. D 1693 Standard Test Method for Environmental Stress-Cracking of Ethylene Plastics
   9. D 3895 Standard Test Method for Oxidative-Induction Time of Polyolefins by Differential Scanning Calorimetry
   10. D 4218 Standard Test Method for Determination of Carbon Black Content in Polyethylene Compounds by the Muffle-Furnace Technique
   11. D 4833 Standard Test Method for Index Puncture Resistance of Geomembranes and Related Products
   12. D 5199 Standard Test Method for Measuring the Nominal Thickness of Geosynthetics

13. D 5397 Standard Test Method for Evaluation of Stress Crack Resistance of Polyolefin Geomembranes Using Notched Constant Tensile Load Test
14. D 5596-03 (2016), Standard Test Method for Microscopic Evaluation of the Dispersion of Carbon Black in Polyolefin Geosynthetics
15. D5641-94 (2011), Standard Practice for Geomembrane Seam Evaluation by Vacuum Chamber
16. D 5820 Standard Practice for Pressurized Air Channel Evaluation of Dual Seamed Geomembranes
17. D 5885 Standard Test Method for Oxidative Induction Time of Polyolefin Geosynthetics by High-Pressure Differential Scanning Calorimetry
18. D 5994 Standard Test Method for Measuring Core Thickness of Textured Geomembranes
19. D 6392 Standard Test Method for Determining the Integrity of Nonreinforced Geomembrane Seams Produced Using Thermo-Fusion Methods
20. D 6693 Standard Test Method for Determining Tensile Properties of Nonreinforced Polyethylene and Nonreinforced Flexible Polypropylene Geomembranes
21. D 6938 Standard Test Methods for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)
22. D 7466 Standard Test Method for Measuring Asperity Height of Textured Geomembranes

1.3 SUBMITTALS

A. Furnish the following product data, in writing, to the Engineer prior to installation of the geomembrane material.

B. Resin Data shall include the following:
1. Certification stating that the resin meets the specification requirements
2. Certifications stating all resin is from the same Manufacturer
3. Copy of Quality Assurance/Quality Control certificates issued by Geomembrane Manufacturer and resin supplier shall be submitted.

C. Each Geomembrane Roll
1. Certification and test results showing that the resin meets the specification requirements
2. Statement certifying no reclaimed polymer is added to resin
3. Copy of quality assurance certificates issued by Geomembrane Manufacturer shall be furnished
4. Submitted to Engineer upon delivery of each roll to site.

D. Extrudate resins and/or rod shall be certified that all extrudate is from one Manufacturer, is the same resin type, and was obtained from the same resin supplier as the resin used to manufacture the geomembrane rolls.

E. Furnish the following information to the Engineer prior to installation
1. Installation layout drawings. Submit drawings showing proposed panel layout including field seams and details. These drawings shall be approved prior to installing the geomembrane. This approval will be for concept only and actual panel placement will be determined by site conditions.
2. Statements of experience from the proposed HDPE supplier and installer

3. Installer's geosynthetic Field Installation Quality Assurance Plan
4. Samples of HDPE proposed for use on project
5. Reference lists from both the HDPE supplier and installer
6. Results of conformance testing specified within Paragraphs 1.4, and 1.5.

F. Submittals on a daily basis during installation
1. Subgrade Acceptance Forms
2. All QC documentation and field testing results (destructive and non-destructive test results)

G. Submit the following to the Engineer upon completion of installation
1. Certificate stating the geomembrane has been installed in accordance with the Contract Documents
2. Material and installation warranties
3. As-built drawings showing actual geomembrane panel placement and seams including typical anchor trench

1.4 CONFORMANCE TESTING

A. The Engineer will sample HDPE materials which have arrived on-site for conformance testing. The Contractor will be responsible for forwarding conformance samples to a certified, third party, testing laboratory for testing. Conformance samples will be taken a minimum of each lot or every 100,000 square feet of material whichever results in more tests. HDPE samples will be tested for thickness, yield, elongation @ yield, elongation @ break, and puncture resistance. Samples will be tested to ensure conformance with the specifications listed within Table 1 of this section.

B. No HDPE material shall be installed until conformance testing is complete on that material and results show that the delivered material meets the requirements of the specifications. Material which fails to meet the requirements of the conformance testing shall be rejected and not utilized within the project. Rejected material will be replaced with material meeting the specifications at no additional cost to the Owner. The Contractor shall pay for all costs associated with this conformance testing and retesting of new material, if necessary.

1.5 FIELD TESTING

A. The Contractor shall submit results of the field destructive and non-destructive field testing in writing to the Engineer at the end of every day in which geomembrane welding and seaming has been conducted. The results shall indicate location of the test, passing or failure of the test, and any remedial action taken.

1.6 AS-BUILT DRAWINGS

A. The Contractor shall maintain and submit as-built drawings showing panel layout with identifying panel numbers, the location of all seams, the location of destructive test samples with identification numbers and the location of all repairs. The Contractor shall submit a table showing the correspondence between the Manufacturer's roll number and the assigned panel numbers. Updated as-built drawings shall be submitted within one week after each one hundred thousand square feet of geomembrane has been installed.

1.7 THE ENGINEER

A. The Engineer reserves the right to, and may place a quality control technician at the geomembrane factory to observe geomembrane manufacturing. Any material rejected at the factory shall not be shipped to the Project Site. Regardless of whether a technician representing the Engineer is present at the factory, or not, the Contractor shall have sole responsibility for meeting the requirements of this specification.

PART 2 - STORAGE

2.1 GENERAL

A. Storage and handling of the geomembrane shall conform to the Manufacturer's recommendation and shall be done in a manner as to prevent damage to any part of the geomembrane. Any portion of the geomembrane that is damaged shall either be repaired or cut out as determined by the Engineer and/or Manufacturer's representative.

PART 3 - MANUFACTURER'S EXPERIENCE

3.1 GENERAL

A. The Manufacturer of the geomembrane material described in these specifications shall have previously demonstrated his ability to produce this membrane by having successfully manufactured a minimum of ten (10) million square feet of similar lining material for hydraulic lining installations.

3.2 60 MIL HDPE LINER, DOUBLE-SIDE TEXTURED

A. Double-side textured geomembrane to be utilized in the landfill cell shall consist of high density polyethylene (HDPE) manufactured of new first quality products designed and manufactured specifically for the purpose of liquid containment. The textured surface shall be manufactured simultaneously with the extrusion of the liner. The geomembrane material shall have a nominal thickness of 60 mil and a minimum thickness of 54 mil and meet the specifications in Table 1.

TABLE 1
GEOMEMBRANE PROPERTIES

General Description: 60 mil HDPE Double-Sided Textured

PROPERTY (min avg roll value-except where specified otherwise)	**TEST**	**SPECIFICATION**
Polymer		HDPE
Nominal Thickness (mils)	ASTM D5994	≥60
Density	ASTM D792/1505	0.94
Tensile Properties		
Yield (lb/in)	ASTM D6693 Type IV	≥ 126
Break (lb/in)	ASTM D6693 Type IV	≥90
Elongation @ Yield (%)	ASTM D6693 Type IV	≥12
Elongation @ Break (%)	ASTM D6693 Type IV	≥100
Puncture Resistance (lb)	ASTM D4833	≥90
Tear Resistance (lb)	ASTM D1004	≥ 42
Seam Strength	ASTM D6392	
Shear Fusion (lb/in)		≥ 120
Shear Extrusion (lb/in)		≥ 120
Peel Fusion (lb/in)		≥ 91
Peel Extrusion (lb/in)		≥ 78
Carbon Black Content (%)	ASTM D 4218	2%-3%

PART 4 - EXECUTION

4.1 GEOMEMBRANE INSTALLER

A. The installation of the geomembrane shall be performed by the Manufacturer of the material or an installer certified by the Manufacturer using the Manufacturer's installation methods. All the installer supervisors overseeing the geomembrane installation shall have over ten million square feet of geomembrane supervisory experience. All field technicians shall have over one million square feet of seaming experience.

4.2 SUBGRADE PREPARATION

A. The HDPE liner shall be placed directly upon the prepared subgrade. The Contractor shall protect the subgrade from flooding and moisture and maintain a compacted, firm and even subgrade for installation of the HDPE.

B. The geomembrane installer shall, prior to commencing installation, certify in writing that the surface on which the geomembrane is to be installed is acceptable. The installer shall also certify that anchor trenches, slopes and grades are acceptable and will not affect the performance or durability of the geomembrane.

4.3 ANCHOR TRENCH SYSTEM

A. Excavation - The anchor trench shall be excavated to the lines and widths shown on the drawings. Trenches shall be excavated only the distance required for that day's installation. The corners of the trench shall be slightly rounded where the geomembrane adjoins the trench to minimize sharp bends.

B. Backfill - Material used to backfill the anchor trenches shall be approved by the Engineer. The material shall be placed in six (6) inch loose lifts and shall be compacted to 95 percent of the maximum dry density at a moisture content within 2 percent of optimum moisture content as defined by ASTM D698. Field compaction tests, utilizing the nuclear method outlined in ASTM D6938 or other methods approved by the Engineer, will be made as backfilling of the anchor trenches proceed.

4.4 FIELD PANEL PLACEMENT

A. Identification and Location of Field Panels - Each panel used for installation shall be given an identification number consistent with the shop drawings. The identification number shall be related to a manufacturing roll number that identifies the resin type, batch number and date of manufacture.

B. Field panels shall be installed at locations shown on the shop drawings. If panels are installed in a location other than that indicated on the shop drawings, the revised location shall be noted in the field on a layout drawing. The Contractor shall provide the Engineer, in writing at the end of each day of geomembrane installation, with the identification and locations of panels installed and notify the Engineer of any revised panel locations.

C. Weather Conditions - Geomembrane shall not be installed during any precipitation, in the presence of excessive moisture, in areas of standing water, or during high winds. The Engineer shall be the final authority on determining proper weather conditions for geomembrane installation.

D. Placement - Geomembrane panels shall be placed using equipment and procedures so as not to damage the geomembrane, the subgrade surface, or GCL and in a manner to minimize both wrinkles and stretching. Sufficient material slack shall be provided to allow for geomembrane expansion and contraction.

E. Personnel working on the geomembrane shall not smoke, wear shoes that can damage the geomembrane or engage in actions which can result in damage to the geomembrane.

F. Damaged panels shall be repaired in accordance with Part Eight of this section or removed. Remedial measures shall be approved by the Engineer.

4.5 TEMPORARY ANCHORAGE

A. Sandbags shall be placed to prevent uplift of the geomembrane by the wind.

4.6 FIELD SEAMING

A. Equipment - Field seam welding equipment shall be capable of continuously monitoring and controlling the temperature in the zone of contact where the machine is joining the geomembrane.

B. Layout - The seams shall be generally oriented parallel to the slope. Where necessary, horizontal seams shall be located five feet minimum from the toe of the slopes. Individual panels of geomembrane material shall be overlapped as recommended by the Manufacturer. The area to be welded shall be cleaned and prepared according to the procedures specified by the Manufacturer.

C. Types of Welds - Geomembrane panels shall be seamed using double track hot wedge welding. Detail seaming around pipes and concrete structures and seaming for patches shall be fabricated with fillet extrusion welds.

D. Weather - Seaming shall not take place when the temperature is below 40°F or above 100°F except under approval of Engineer. Seaming shall not take place during rain, snow, sleet or other wet conditions or when the subgrade beneath the geomembrane is frozen. The Engineer shall be the final authority on determining proper weather conditions for seaming.

PART 5 - FACTORY FABRICATION QUALITY CONTROL

5.1 MANUFACTURING QUALITY ASSURANCE & CONTROL

A. The Manufacturer of geomembrane material shall perform quality control testing of all geomembrane produced in accordance with the Geosynthetics Research Institute Standards GM-13. Certified results of factory quality control testing shall be submitted to the Engineer prior to or upon delivery to the site.

PART 6 - TEST WELDS

6.1 SAMPLING

A. Test welds shall be performed at the beginning of each seaming period and at least once each five (5) hours for each welding apparatus used that day. Test welds shall be made under the same conditions as exist for the geomembrane seaming. The test welds shall be at least three feet long and shall be made by joining pieces of geomembrane at least nine inches wide.

6.2 FIELD TESTING

A. Two random samples shall be cut from the test weld. The samples shall be tested in shear and in peel in accordance with ASTM D6392 using a field extensiometer supplied and operated by the Installer. The welds shall exhibit a Film Tearing Bond (FTB). If a specimen fails, the entire sampling and testing procedure shall be repeated. If any of the second set of specimens fail, the welding machine shall not be accepted for seaming until the deficiencies have been corrected and a passing test seam achieved.

PART 7 - FIELD SEAM TESTING

7.1 GENERAL

A. One hundred percent (100%) of all field seams shall be subjected to Engineer approved non-destructive seam testing.

7.2 AIR PRESSURE TESTING

A. All double-track welds shall be air pressure tested to a minimum of 25 psi according to the Manufacturer's recommendations. The pressure may not drop over 4 psi in a five-minute period or the seam fails. Failing seams shall be remedied according to the Manufacturer's recommendations until the seam passes the air pressure tests. Air pressure feed holes shall be repaired by extrusion welding.

7.3 VACUUM BOX TESTING

A. All extrusion welds shall be vacuum tested in accordance with Manufacturer's recommendations.

7.4 DESTRUCTIVE TESTING - LABORATORY

A. One (1) destructive test sample shall be taken randomly at a minimum average frequency of one (1) test location every 500 feet of seam length and submitted to the Engineer. Seam destructive samples shall be sent by the Engineer to an approved third party laboratory and tested for shear strength and peel adhesion (ASTM D6392). Testing shall be paid for by the Contractor. Five (5) specimens shall be tested for each test method. Four (4) out of the five (5) specimens must exhibit FTB for each round of peel and shear testing. In addition, four (4) of the five (5) individual specimens and the average of the five (5) peel and shear tests must meet or exceed the specified strength requirements.

7.5 DESTRUCTIVE TESTING - FIELD

A. The Installer shall duplicate the laboratory testing (Section 7.4) using a field extensiometer provided by the Installer. The results of field testing shall be submitted to the Engineer immediately after testing.

PART 8 - REPAIRS

8.1 GENERAL

A. All seams which have failed destructive or non-destructive tests shall be repaired. All defects, holes, blisters or other signs of damage shall also be repaired. Repairs shall be conducted under the supervision of the Engineer according to the Manufacturer's specifications. Every repair shall be non-destructively tested according to Part 7 of this specification. Repairs in excess of 150 lineal feet shall require a destructive test.

PART 9 - DOCUMENTATION

9.1 GENERAL

A. The Contractor shall provide the Engineer with the following documentation for approval before, during and after liner installation as appropriate:

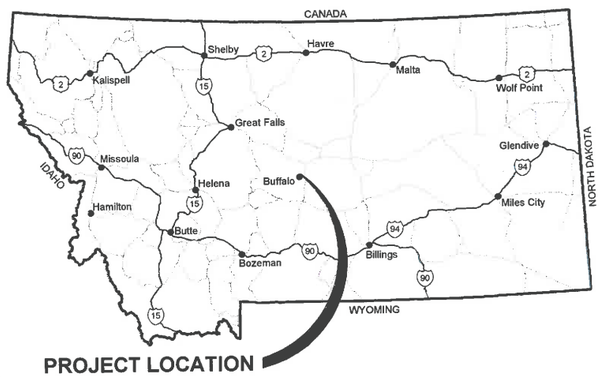
1. Geomembrane layout sequence
2. Details of welding and seaming operations
3. Non-destructive seam testing methods and schedule
4. Test weld method and schedule
5. Manhole welding details
6. Destructive test sampling from field seamed liner and schedule
7. Repair procedures
8. QA/QC Plan
9. QA/QC forms for job
   a. Delivery/Inventory Checklist
   b. Panel Placement Form
   c. Test Weld Form
   d. Panel Seaming Form
   e. Non-Destructive Testing Form
   f. Destructive Test Log
   g. Daily Field Report
10. As-built drawings of panel placements

PART 10 - WARRANTY AND GUARANTEE

10.1 GENERAL

A. The manufacturer and installer shall each provide a written warranty. The manufacturer shall provide a five-year warranty on the material. The installer shall provide a two-year warranty on the installation.

END OF SECTION



PETERSON RANCH
BUFFALO CANYON FEEDERS, LLC CAFO

CONSTRUCTION PLANS

SECTIONS 1 AND 2, TOWNSHIP 12 N., AND RANGE 15 E.

NOT TO SCALE

SHEET INDEX

PROJECT: 1-20165
DATE: JULY 7, 2020

PLANS PREPARED FOR:

ROBERT PETERSON
BUFFALO CANYON FEEDERS, LLC

APPROVED BY:

ROBERT E. CHURCH, P.E.
GREAT WEST ENGINEERING

ROBERT E. CHURCH 9707 P.E. REGISTERED PROFESSIONAL ENGINEER STATE OF MONTANA
7-7-2020

PLANS PREPARED BY:

BRET ANDERSON

GreatWest engineering ®
2501 BELT VIEW DRIVE
HELENA, MT 59601
(406)449-8627

NO.	REVISION DESCRIPTION	BY	DATE
1			
2			
3			
4			
5			
6			

SET NO.

SHEET NO. 1

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ABBREVIATIONS

@	AT
Δ	ANGLE OF DEFLECTION, DELTA ANGLE
<PT	ANGLE POINT
AB	ANCHOR BOLT
ABDN	ABANDON
AC	ASBESTOS CONCRETE
ADDN	ADDITIONAL
ADJ	ADJACENT
AFF	ABOVE FINISHED FLOOR
ALT	ALTERNATE
ANSI	AMERICAN NATIONAL STANDARDS INSTITUTE
APPROX	APPROXIMATE
APVD	APPROVED
ARCH	ARCHITECTURE, ARCHITECTURAL
ASPH	ASPHALT
AVE	AVENUE
AVG	AVERAGE
BFV	BUTTERFLY VALVE
BLDG	BUILDING
BLK	BLOCK
BLVD	BOULEVARD
BM	BEAM, BENCHMARK
BOT	BOTTOM
BRG	BEARING
BRKT	BRACKET
BVC	BEGIN VERTICAL CURVE
C–C	CENTER TO CENTER
CHAN	CHANNEL
CHK	CHECK
CI	CAST IRON
CIPC	CAST–IN–PLACE CONCRETE
CIRC	CIRCULAR
CJ	CONSTRUCTION JOINT, CONTROL JOINT
℄	CENTER LINE
CLR	CLEAR, CLEARANCE
CMP	CORRUGATED METAL PIPE
CMU	CONCRETE MASONRY UNITS
CO	CLEANOUT
COL	COLUMN
CONC	CONCRETE
CONSTR	CONSTRUCTION
CONT	CONTINUE, CONTINUED, CONTINUOUS
CONTR	CONTRACTOR
COORD	COORDINATE
CP	CONTROL PANEL, CONTROL POINT
CPLG	COUPLING
CTR	CENTER
CTV	CABLE TELEVISION
CU	CUBIC, COPPER
CF	CUBIC FEET
CULV	CULVERT
CY	CUBIC YARD
DET	DETAIL
DI	DUCTILE IRON, DRAIN INLET
DIA, ø	DIAMETER
DIAG	DIAGONAL
DIM	DIMENSION
DR	DRIVE
DWG	DRAWING
E	EAST
EA	EACH
EL, ELEV	ELEVATION
ELB	ELBOW
ELEC	ELECTRIC, ELECTRICAL
ENCL	ENCLOSE
ENGR	ENGINEER
EOP	EDGE OF PAVEMENT
EQ	EQUAL, EQUALLY
EQ SP	EQUALLY SPACED
EQUIP	EQUIPMENT
EQUIV	EQUIVALENT
EVC	END VERTICAL CURVE
EW	EACH WAY
EXC	EXCAVATE
EXP	EXPANSION
EXP JT	EXPANSION JOINT
EXST	EXISTING
FCV	FLOW CONTROL VALVE
FD	FLOOR DRAIN
FDN	FOUNDATION
FES	FLARED END SECTION
FET	FLARED END TERMINAL
FF	FINISHED FLOOR
FG	FINISH GRADE
FHYD	FIRE HYDRANT
FJ	FLANGE JOINT
FL	FLOW LINE
FLEX	FLEXIBLE
FM	FORCEMAIN
FT	FOOT, FEET
FO	FIBER OPTIC
FTG	FOOTING, FITTING
G	NATURAL GAS
GA	GAGE, GAUGE
GAL	GALLON
GALV	GALVANIZED
GND	GROUND
GVL	GRAVEL
HB	HOSE BIB
HDPE	HIGH DENSITY POLYETHYLENE
HOR, HORIZ	HORIZONTAL
HWY	HIGHWAY
HYD	HYDRANT
ID	INSIDE DIAMETER
IE	INVERT ELEVATION
IN	INCH
INV	INVERT
JB	JUNCTION BOX
JT	JOINT
K	RATE OF VERTICAL CURVATURE
LBS	POUNDS
LF	LINEAR FEET
LN	LANE
LPG	LIQUID PROPANE GAS
LT	LEFT
MAX	MAXIMUM
MD	MEASURE DOWN
MFD	MANUFACTURED
MFR	MANUFACTURE, MANUFACTURER
MH	MANHOLE
MIN	MINIMUM
MISC	MISCELLANEOUS
MJ	MECHANICAL JOINT
MOV	MOTOR OPERATED VALVE
MPWSS	MONTANA PUBLIC WORKS STANDARD SPECIFICATIONS
N	NORTH
NE	NORTHEAST
NG	NATURAL GAS
NIC	NOT IN CONTRACT
NO	NUMBER
NOM	NOMINAL
NTS	NOT TO SCALE
NW	NORTHWEST
OC	ON CENTER
OD	OUTSIDE DIAMETER
OF	OVERFLOW
OH	OVERHEAD
OHP	OVERHEAD POWER
OHT	OVERHEAD TELEPHONE
OPNG	OPENING
PC	POINT OF CURVATURE
PCC	POINT OF COMPOUND CURVATURE
PE	PLAIN END, POLYETHYLENE
PERP	PERPENDICULAR
PI	POINT OF INTERSECTION
ℙ	PROPERTY LINE
PNL	PANEL
PRC	POINT OF REVERSE CURVATURE
PREFAB	PREFABRICATED
PRELIM	PRELIMINARY
PREP	PREPARE, PREPARATION
PROP	PROPERTY
PRV	PRESSURE REDUCING VALVE
PSF	POUNDS PER SQUARE FOOT
PSI	POUNDS PER SQUARE INCH
PT	POINT, POINT OF TANGENCY
PVC	POLYVINYL CHLORIDE
PVI	POINT OF VERTICAL INTERSECTION
PVMT	PAVEMENT
R, RAD	RADIUS
RC	REINFORCED CONCRETE
RCP	REINFORCED CONCRETE PIPE
RD	ROAD
RDCR	REDUCER
REBAR	REINFORCEMENT BAR
REF	REFERENCE
REINF	REINFORCE
REQD	REQUIRED
RR	RAILROAD
RST	REINFORCING STEEL
RT	RIGHT
R/W	RIGHT–OF–WAY
S	SOUTH, SANITARY SEWER
SAN	SANITARY
SCH	SCHEDULE
SD	STORM DRAIN
SDWK	SIDEWALK
SE	SOUTHEAST
SECT	SECTION
SF	SQUARE FOOT
SHT	SHEET
SIM	SIMILAR
SLP	SLOPE
SPEC	SPECIFICATION
SQ	SQUARE
SSTL	STAINLESS STEEL
STA	STATION
SS	SANITARY SEWER SERVICE
STD	STANDARD
ST	STREET
STL	STEEL
STRUCT	STRUCTURE
SW	SOUTHWEST
SYM	SYMMETRICAL
TB	THRUST BLOCK
TBC	TOP BACK OF CURB
TBM	TEMPORARY BENCH MARK
TEL	TELEPHONE
TEMP	TEMPORARY
THRU	THROUGH
TYP	TYPICAL
UG	UNDERGROUND
UGP	UNDERGROUND POWER
UGT	UNDERGROUND TELEPHONE
UTIL	UTILITY
V	VALVE, VOLT
VB	VALVE BOX
VERT	VERTICAL
VOL	VOLUME
W	WEST, WATER
WTR	WATER
WD	WOOD
W/	WITH
W/O	WITHOUT
WL	WETLAND
WM	WIRE MESH, WATER METER
WS	WATERSTOP, WATER SURFACE, WATER SERVICE
WT	WEIGHT
WV	WATER VALVE
WWF	WELDED WIRE FABRIC
WWM	WELDED WIRE MESH
XFMR	TRANSFORMER
X–ING	CROSSING
XS	CROSS SECTION
YD	YARD

LEGEND

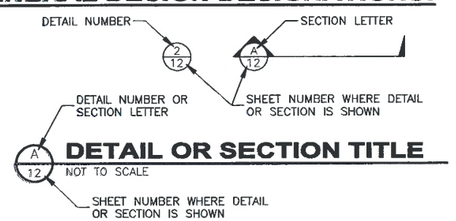
EXISTING	PROPOSED	DESCRIPTION
		MAJOR CONTOUR
		MINOR CONTOUR
OHT	OHT	OVERHEAD TELEPHONE
UGT	UGT	UNDERGROUND TELEPHONE
CTV	CTV	CABLE TELEVISION
FO	FO	FIBER OPTIC
G	G	NATURAL GAS
OHP	OHP	OVERHEAD POWER
UGP	UGP	UNDERGROUND POWER
S	S	SANITARY SEWER
SS	SS	SANITARY SEWER SERVICE
FM	FM	SANITARY SEWER FORCEMAIN
SD	SD	STORM DRAIN
		STORM CULVERT
W	W	WATER
WS	WS	WATER SERVICE
		CHAINLINK FENCE
		BARBED WIRE FENCE
		WOOD FENCE
		PAVED ROAD
		GRAVEL ROAD
		PROPERTY/LOT LINE
		PROPERTY EASEMENT
		PROPERTY SETBACK
		RIGHT–OF–WAY
		CITY LIMIT/DISTRICT BOUNDARY
		RAILROAD
		DITCH
		WATER EDGE
WL		WETLAND
		BUILDING
		BENCHMARK
		CONTROL POINT
		PROPERTY PIN
		BORING
		MONITORING WELL
		TEST PIT
		BOLLARD
		MAIL BOX
		SIGN

EXISTING	PROPOSED	DESCRIPTION
		STUMP
		SHRUB/BUSH
		TREE–CONIFER
		TREE–DECIDUOUS
		TREE LINE
C		COMMUNICATION MANHOLE
C		COMMUNICATION VAULT
T	T	TELEPHONE RISER
TV	TV	CABLE TV RISER
		NATURAL GAS METER
G	G	NATURAL GAS RISER
		NATURAL GAS VALVE
		LIGHT POLE
		STREET LIGHT POLE
P	P	POWER RISER
		PAD MOUNTED TRANSFORMER
P	P	POWER VAULT
		UTILITY POLE
		GUY WIRE
S	S	SANITARY MANHOLE
CO		SANITARY CLEANOUT
		SANITARY LAMPHOLE
ST	ST	STORM MANHOLE
		STORM ROUND INLET
		STORM SQUARE INLET
		STORM CATCH BASIN
		11.25° ELBOW
		22.50° ELBOW
		45° ELBOW
		90° ELBOW
		TEE
		CROSS
		CAP
		FIRE HYDRANT
		GATE VALVE
		REDUCER
		WATER METER
W	W	WELL
		CURB STOP
		FROST FREE HYDRANT

GENERAL NOTES:

1. THIS IS A STANDARD LEGEND AND ABBREVIATION LIST. THEREFORE, NOT ALL SYMBOLS AND ABBREVIATIONS MAY BE USED ON THIS PROJECT.
2. UNLESS MODIFIED BY THE CONTRACT DOCUMENTS, ALL WORK WILL CONFORM TO THE MONTANA PUBLIC WORKS STANDARD SPECIFICATIONS, SIXTH EDITION, APRIL 2010 (REFERRED TO COLLECTIVELY AS MPWSS).
3. EXISTING UNDERGROUND UTILITIES SHOWN ARE FROM THE BEST INFORMATION AVAILABLE. THIS INFORMATION IS APPROXIMATE AND MAY BE INCOMPLETE. FOR ACCURATE LOCATION, THE CONTRACTOR SHALL CONTACT, PRIOR TO EXCAVATION, THE UTILITIES UNDERGROUND LOCATION CENTER AT: 1–800–424–5555.

GENERAL DESIGN DESIGNATIONS:



NO.	REVISION DESCRIPTION	BY	DATE

PROJECT: 1-20165
DESIGNED: REC / BAA
DRAWN: BAA
CHECKED: REC
APPROVED: REC
DATE: JULY 7, 2020

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2501 BELT VIEW DRIVE
HELENA, MT 59601
(406)449-8627

PETERSON RANCH
BUFFALO CANYON FEEDERS, LLC CAFO

LEGEND - ABBREVIATIONS AND GENERAL NOTES

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OF 12

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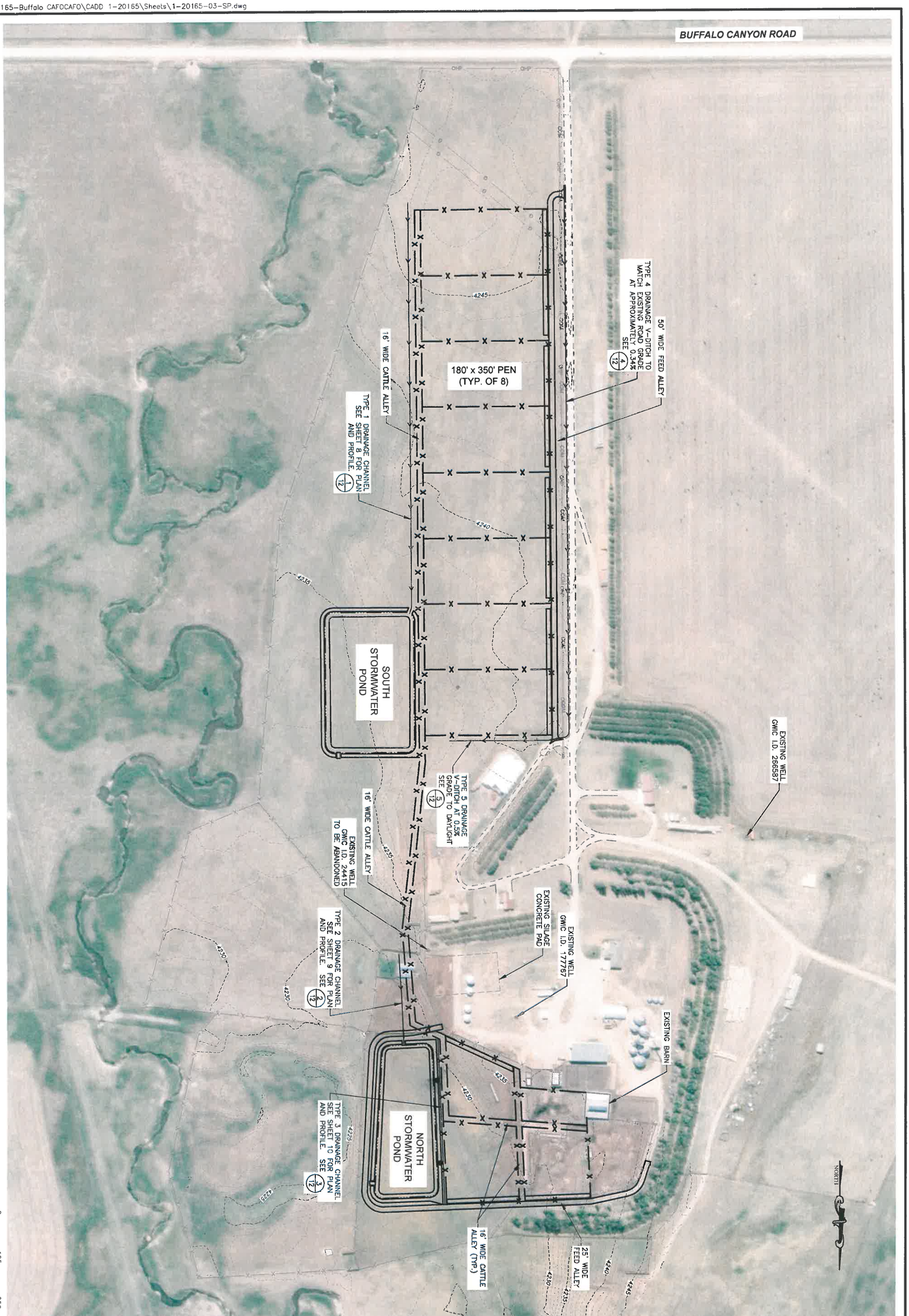

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SITE PLAN

SHEET NO. 3 OF 12

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APPROVED: REC
DATE: JULY 7, 2020

NO.	REVISION DESCRIPTION	BY	DATE
1			
2			
3			
4			
5			

NORTH

12" CULVERT

TYPE 4 DRAINAGE V-DITCH TO MATCH EXISTING ROAD GRADE AT APPROXIMATELY 0.34%. SEE 4/12

50' WIDE FEED ALLEY

15' WIDE x 8" GRAVEL ROAD

FEED BUNK WITH 12' WIDE CONCRETE SLAB (TYP.)

2 - 15' GATES (TYP.)

12" CULVERT

15' GATE

15' GATE

TYPE 5 DRAINAGE V-DITCH AT 0.5% GRADE TO DAYLIGHT SEE 5/12

180' x 350' PEN (TYP. OF 8)

MATCH EXISTING

SOUTH STORMWATER POND

16' WIDE CATTLE ALLEY

TYPE 1 DRAINAGE CHANNEL SEE SHEET 8 FOR PLAN AND PROFILE. SEE 1/12

SEE SHEET 6

SEE SHEET 6

SPILLWAY SEE 3/11

POND EMBANKMENT SEE 2/11

LINER VENT AT 50' O.C. EACH WAY SEE 4/11

4232.50

4231.50

4245

4240

4235

3.00%

1.50%

1.07%

0.25%

0 60 120

SCALE IN FEET

NO.	REVISION DESCRIPTION	BY	DATE

PROJECT: 1-20165
DESIGNED: REC / BAA
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APPROVED: REC
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GRADING PLAN

SHEET NO.
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OF 12

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NORTH

MATCH EXISTING

SEE SHEET 7

EXISTING BARN
SEE SHEET 7

EXISTING WELL
GWIC I.D. 177767

EXISTING SILAGE
CONCRETE PAD

FEED BUNK WITH 12' WIDE
CONCRETE SLAB (TYP.)

SEE SHEET 7

TYPE 3
DRAINAGE CHANNEL
SEE SHEET 10 FOR
PLAN AND PROFILE
SEE 3/12

25' WIDE
FEED ALLEY

16' WIDE
CATTLE ALLEY

FEED BUNK WITH 12' WIDE
CONCRETE SLAB (TYP.)

16' WIDE CATTLE ALLEY

15' WIDE x 8"
GRAVEL ROAD

COM OHP

180' x 350' PEN
(TYP. OF 8)

TYPE 5 DRAINAGE
V-DITCH AT 0.5%
GRADE TO DAYLIGHT
SEE 5/12

EXISTING WELL
GWIC I.D. 24415
TO BE ABANDONED

MATCH EXISTING

MATCH EXISTING

16' WIDE CATTLE ALLEY

SOUTH
STORMWATER
POND

NORTH
STORMWATER
POND

4226.50

4225.50

POND EMBANKMENT
SEE 1/11

TYPE 2 DRAINAGE CHANNEL
SEE SHEET 9 FOR PLAN
AND PROFILE. SEE 2/12

12" CULVERT

15' WIDE x 8"
GRAVEL ROAD

SPILLWAY
SEE 3/11

LINER VENT AT 50'
O.C. EACH WAY
SEE 4/11

0 60 120
SCALE IN FEET

NO.	REVISION DESCRIPTION	BY	DATE

PROJECT: 1-20165
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APPROVED: REC
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ROBERT E. CHURCH 9707PE REGISTERED PROFESSIONAL ENGINEER STATE OF MONTANA 7-7-2020

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HELENA, MT. 59601
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GRADING PLAN

SHEET NO.
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OF 12

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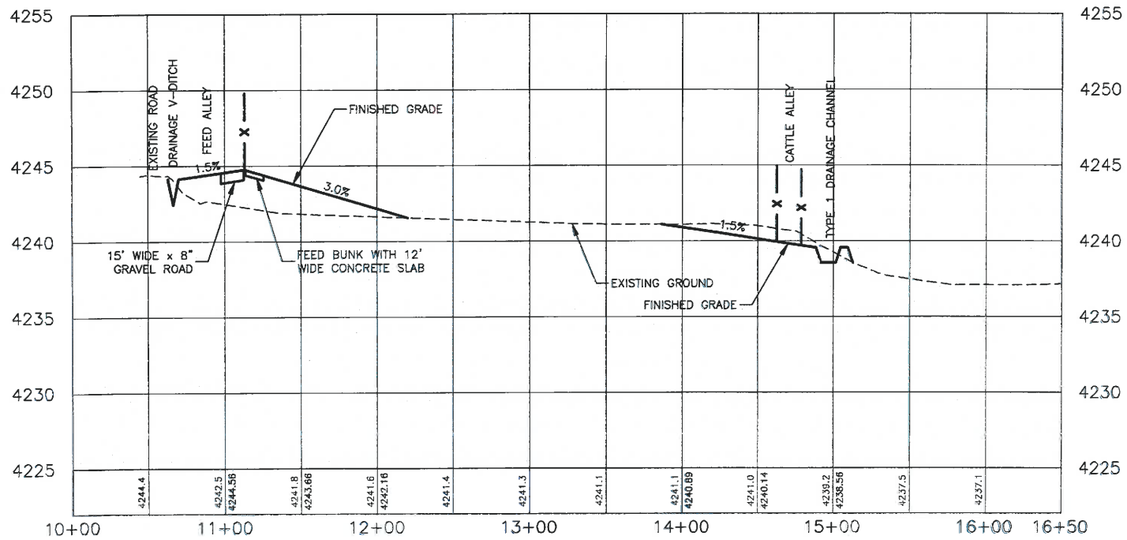
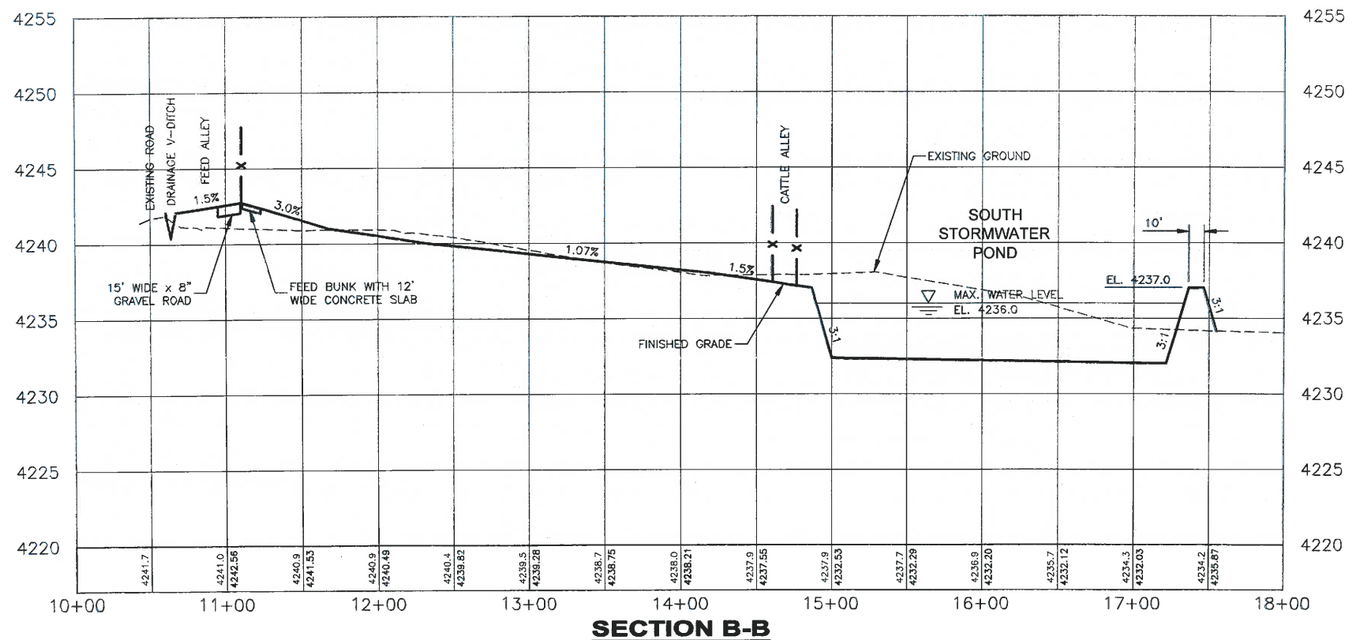


SECTION A-A

HORIZONTAL SCALE: 1" = 100'
VERTICAL SCALE: 1" = 10'



SECTION B-B

HORIZONTAL SCALE: 1" = 100'
VERTICAL SCALE: 1" = 10'

NO.	REVISION DESCRIPTION	BY	DATE

PROJECT: 1-20165
DESIGNED: REC / BAA
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APPROVED: REC
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ROBERT E. CURRY 9707 REGISTERED PROFESSIONAL ENGINEER MONTANA
7-7-2020

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SECTIONS

SHEET NO.
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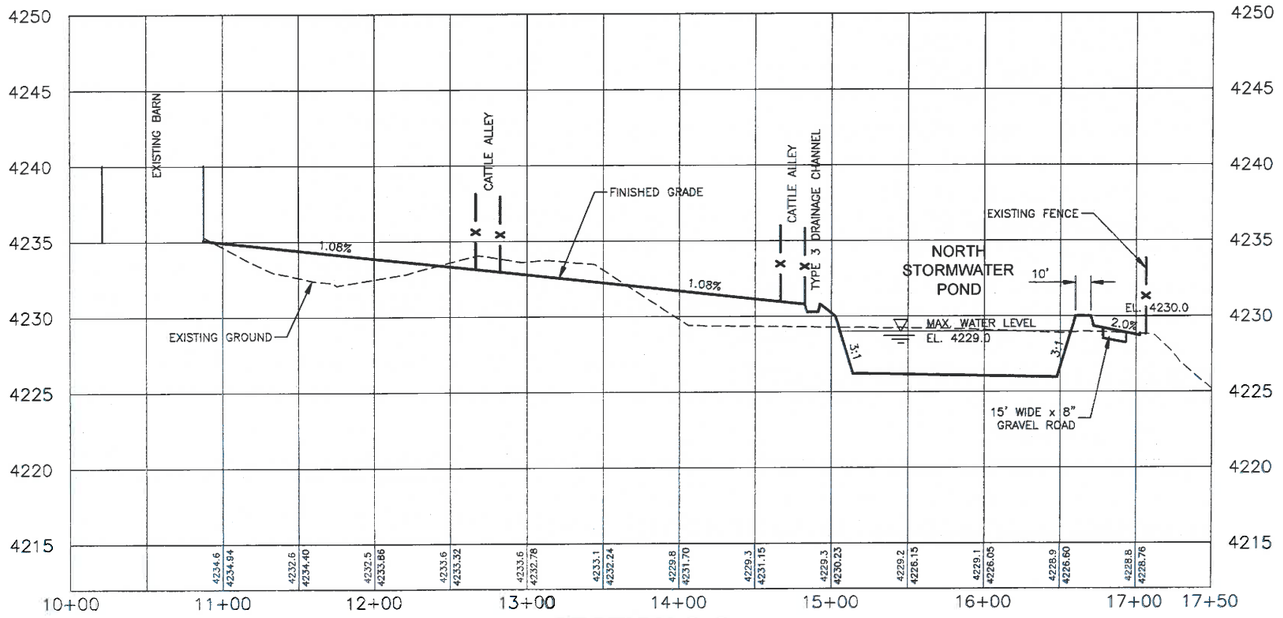
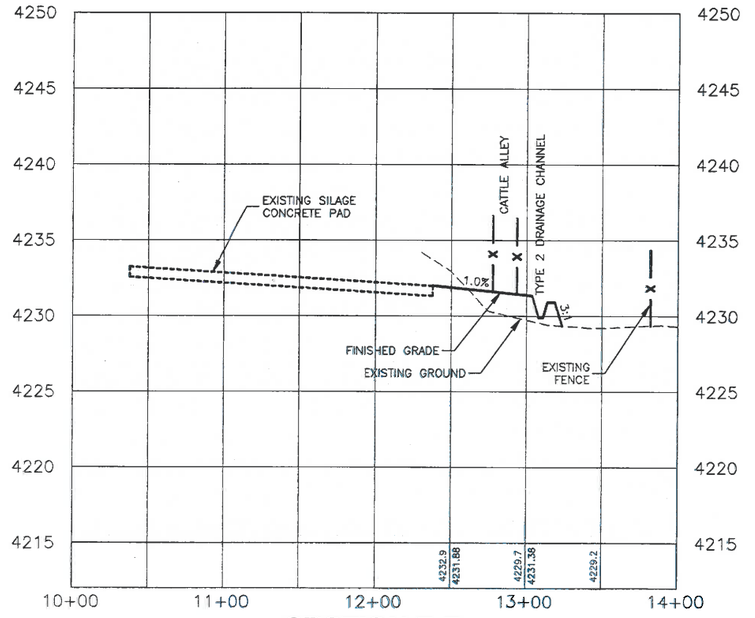


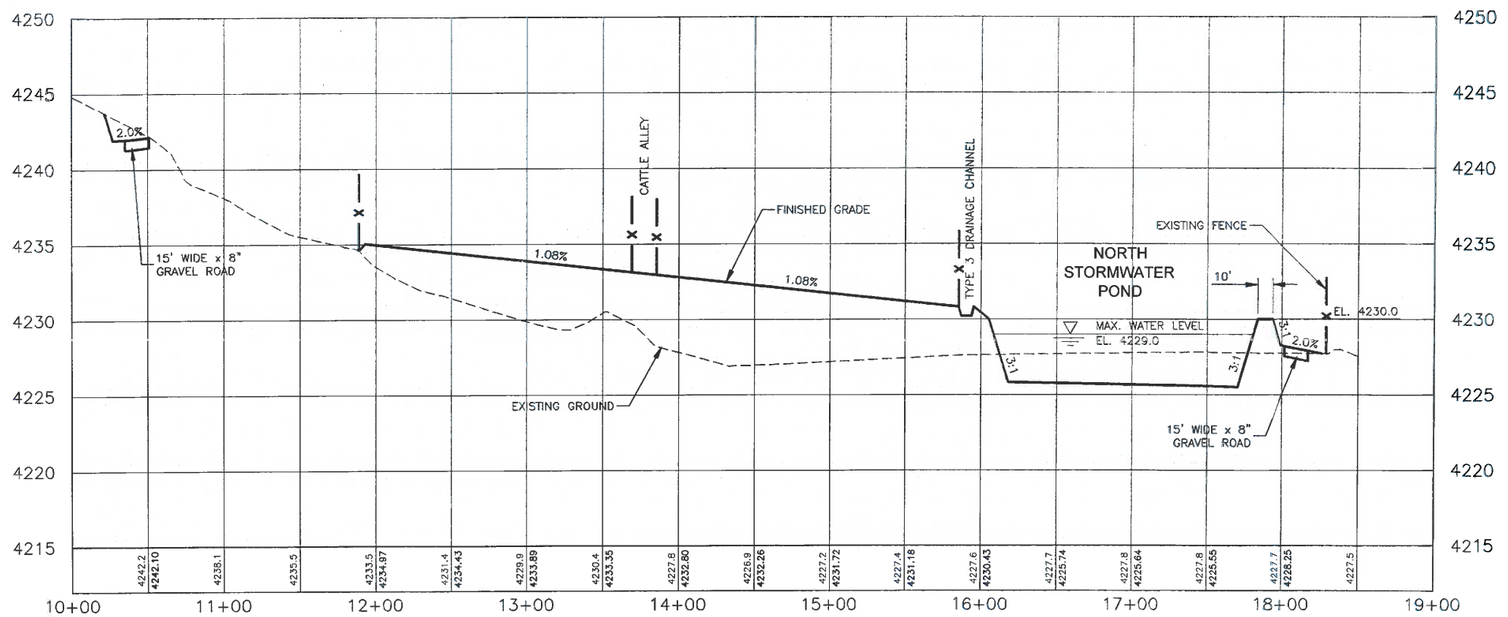
SECTION C-C

HORIZONTAL SCALE: 1" = 100'
VERTICAL SCALE: 1" = 10'



SECTION E-E

HORIZONTAL SCALE: 1" = 100'
VERTICAL SCALE: 1" = 10'



SECTION D-D

HORIZONTAL SCALE: 1" = 100'
VERTICAL SCALE: 1" = 10'

NO.	REVISION DESCRIPTION	BY	DATE

PROJECT: 1-20165
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APPROVED: REC
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HELENA, MT 59601
(406)449-8627

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OF 12

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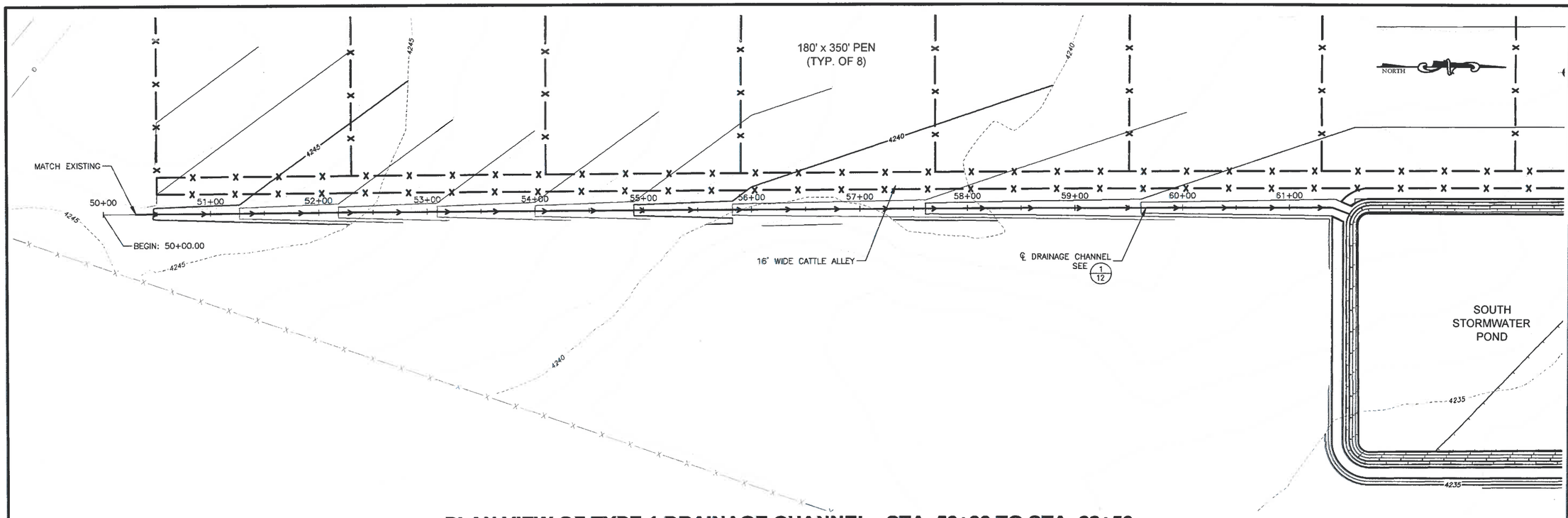
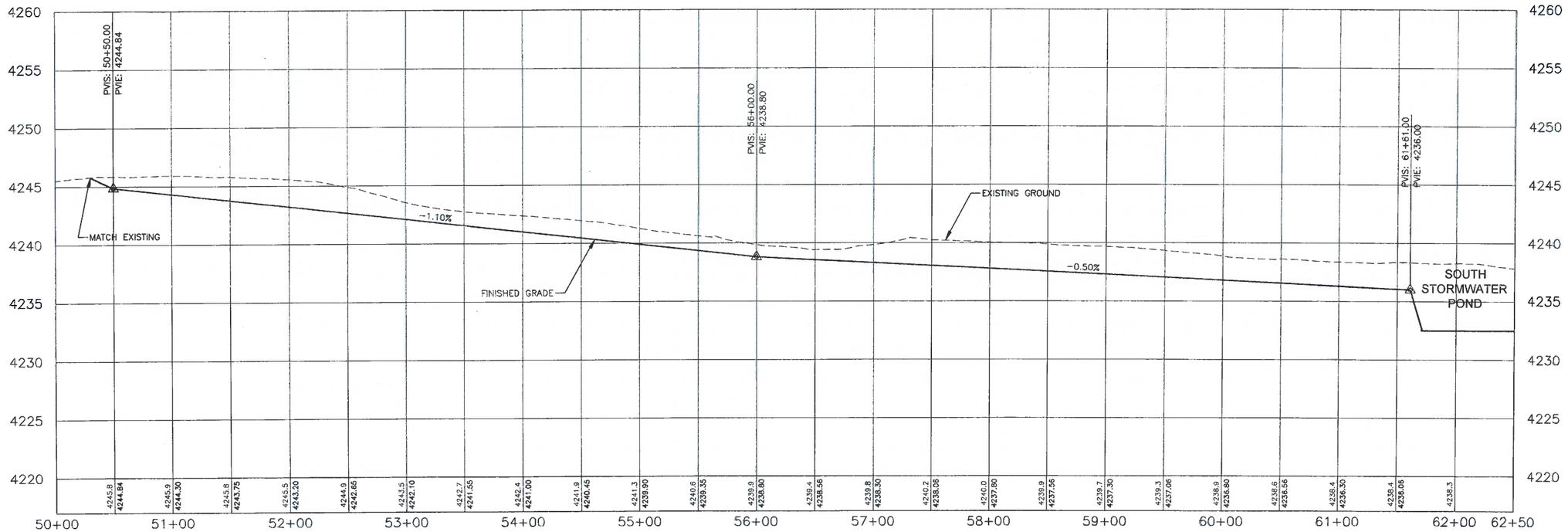


PLAN VIEW OF TYPE 1 DRAINAGE CHANNEL - STA. 50+00 TO STA. 62+50

0 50 100
SCALE IN FEET



PROFILE VIEW OF TYPE 1 DRAINAGE CHANNEL - STA. 50+00 TO STA. 62+50

HORIZONTAL SCALE: 1" = 100'
VERTICAL SCALE: 1" = 10'

NO.	REVISION DESCRIPTION	BY	DATE

PROJECT: 1-20165
DESIGNED: REC / BAA
DRAWN: BAA
CHECKED: REC
APPROVED: REC
DATE: JULY 7, 2020

ROBERT A. CHURCH 9707 REGISTERED PROFESSIONAL ENGINEER STATE OF MONTANA
7-7-2020

GreatWest engineering®
2501 BELT VIEW DRIVE
HELENA, MT 59601
(406)449-8627

PETERSON RANCH
BUFFALO CANYON FEEDERS, LLC CAFO
TYPE 1 DRAINAGE CHANNEL PLAN AND PROFILE
STA. 50+00 TO STA. 62+50

SHEET NO.
8
OF 12

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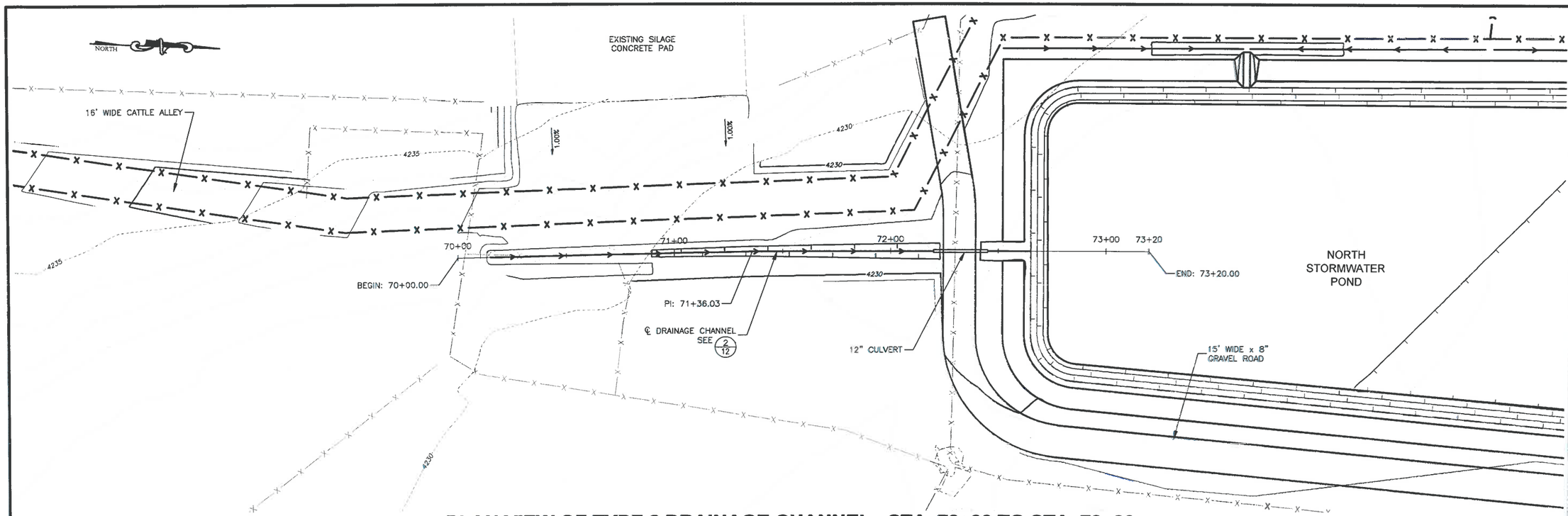
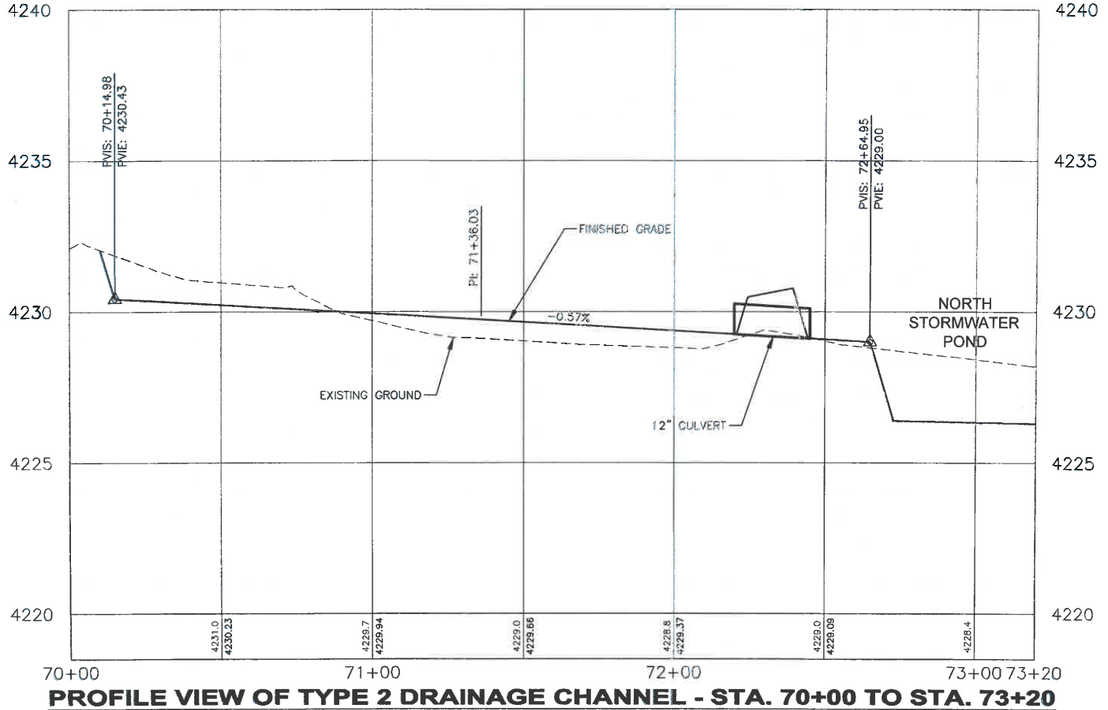


PLAN VIEW OF TYPE 2 DRAINAGE CHANNEL - STA. 70+00 TO STA. 73+20

0 25 50
SCALE IN FEET



PROFILE VIEW OF TYPE 2 DRAINAGE CHANNEL - STA. 70+00 TO STA. 73+20

HORIZONTAL SCALE: 1" = 50'
VERTICAL SCALE: 1" = 5'

NO.	REVISION DESCRIPTION	BY	DATE

PROJECT: 1-20165
DESIGNED: REC / BAA
DRAWN: BAA
CHECKED: REC
APPROVED: REC
DATE: JULY 7, 2020

7-7-2020

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BUFFALO CANYON FEEDERS, LLC CAFO

TYPE 2 DRAINAGE CHANNEL PLAN AND PROFILE
STA. 70+00 TO STA. 73+20

SHEET NO.
9
OF 12

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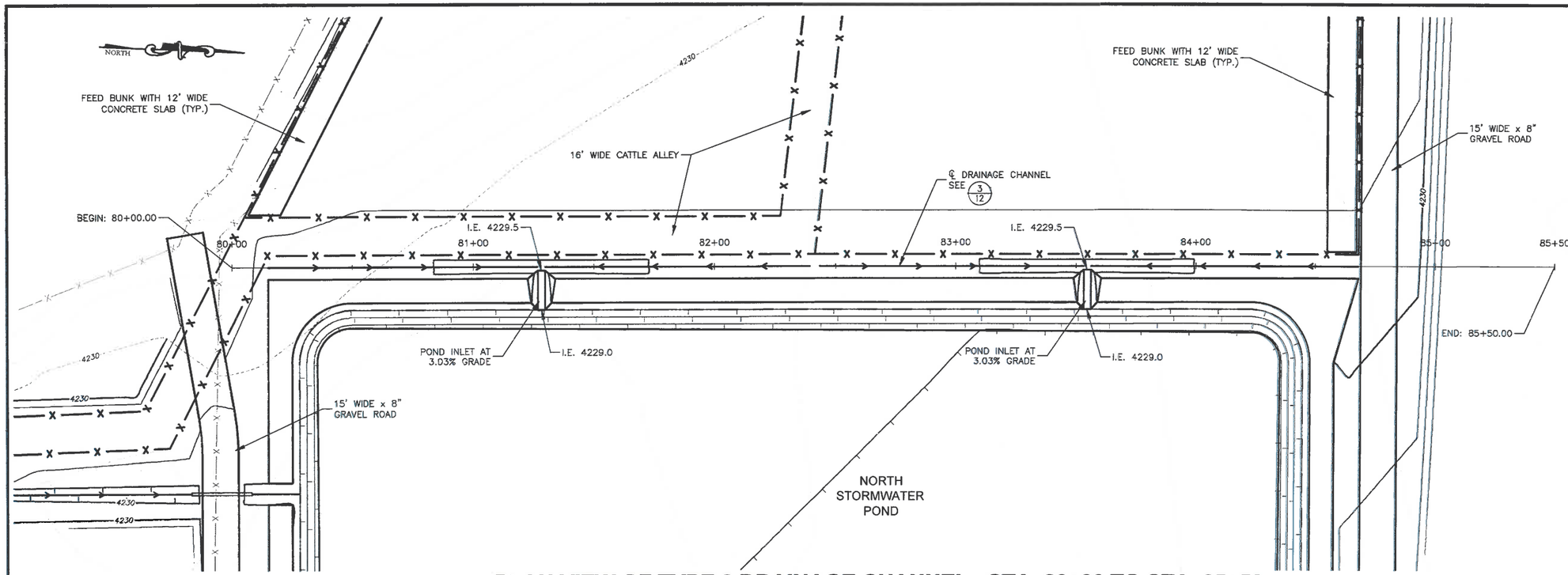
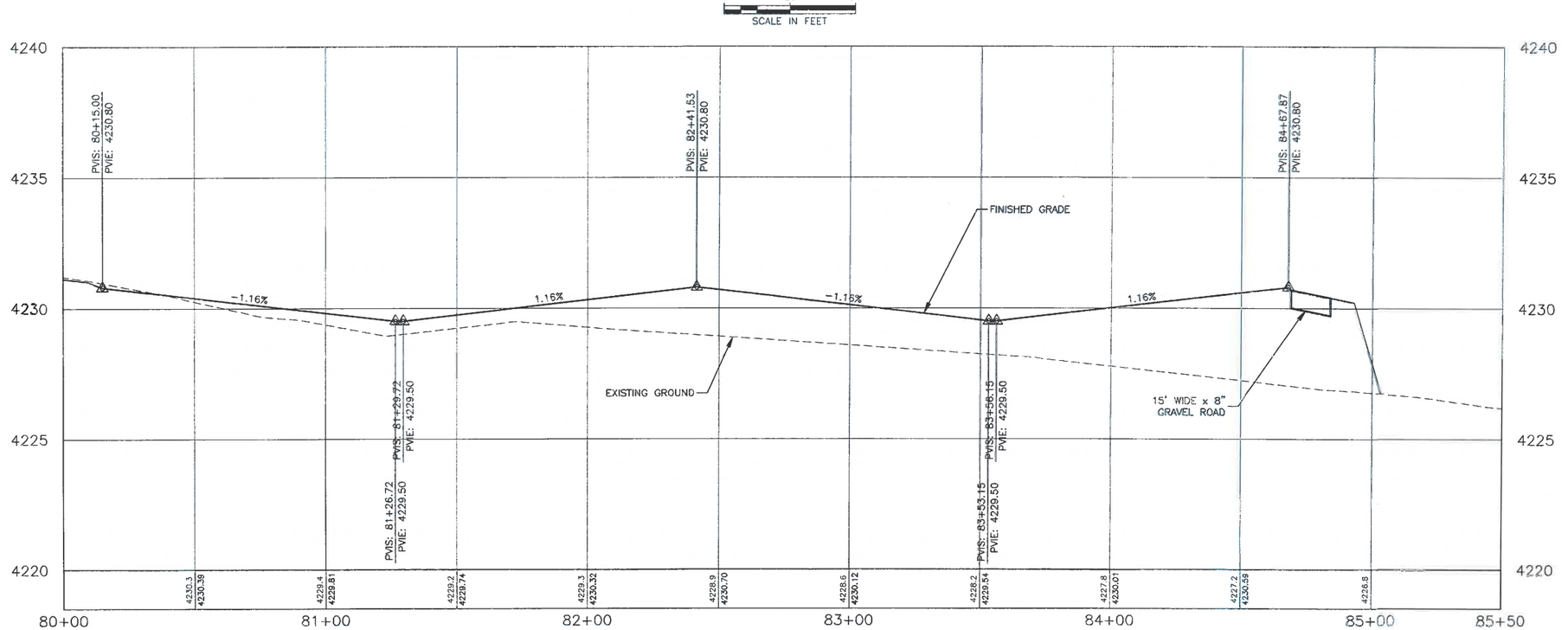


PLAN VIEW OF TYPE 3 DRAINAGE CHANNEL - STA. 80+00 TO STA. 85+50

0 25 50
SCALE IN FEET



PROFILE VIEW OF TYPE 3 DRAINAGE CHANNEL - STA. 80+00 TO STA. 85+50

HORIZONTAL SCALE: 1" = 50'
VERTICAL SCALE: 1" = 5'

NO.	REVISION DESCRIPTION	BY	DATE

PROJECT: 1-20165
DESIGNED: REC / BAA
DRAWN: BAA
CHECKED: REC
APPROVED: REC
DATE: JULY 7, 2020

ROCKY E. CHURCH 9707 REGISTERED PROFESSIONAL ENGINEER STATE OF MONTANA
7-7-2020

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TYPE 3 DRAINAGE CHANNEL PLAN & PROFILE
STA. 80+00 TO STA. 85+50

SHEET NO.
10
OF 12

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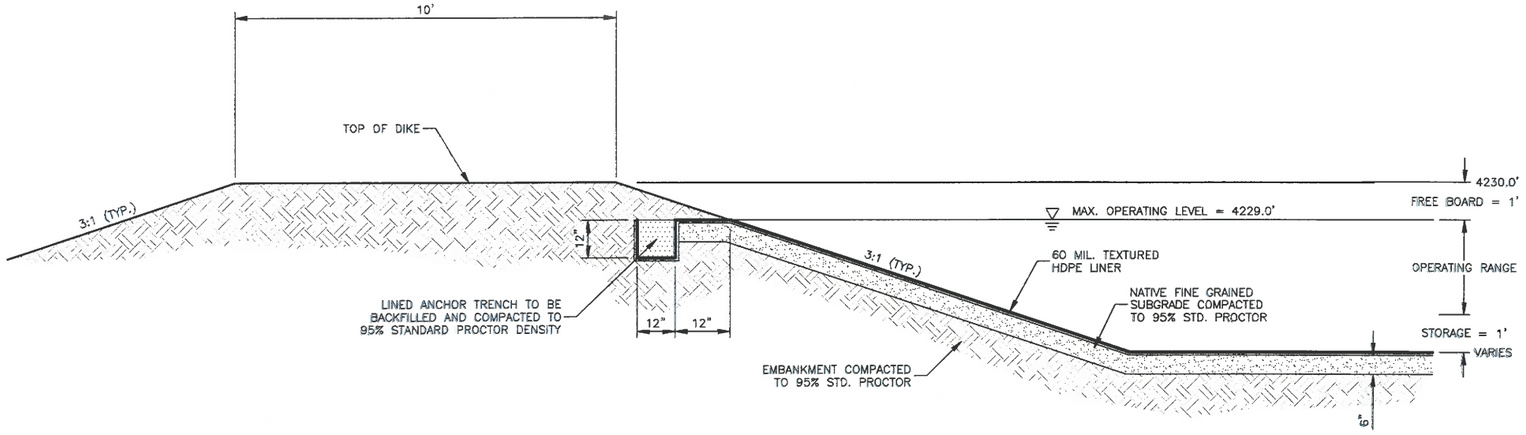
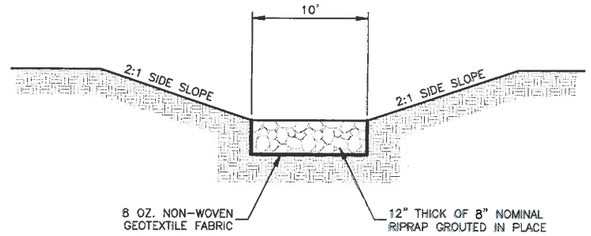
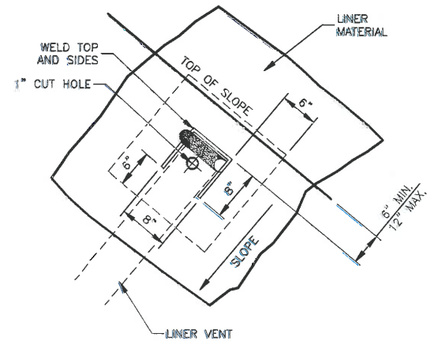


GENERAL NOTES:
1. EMBANKMENT TO BE CONSTRUCTED & COMPACTED AS SPECIFIED IN SECTION 02300 – EARTHWORK.

1/11 NORTH STORMWATER POND EMBANKMENT
NOT TO SCALE

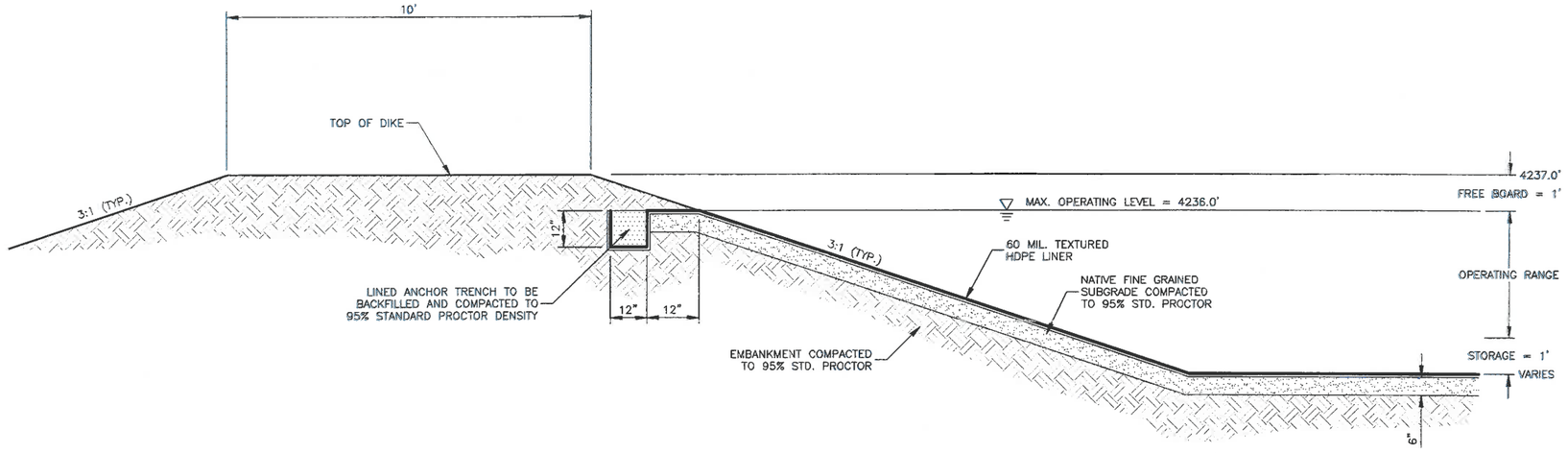


3/11 SPILLWAY SECTION
NOT TO SCALE



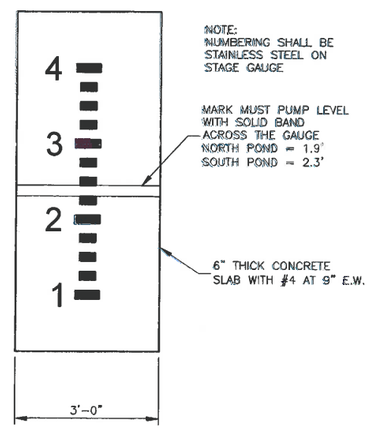
NOTES:
1. LOCATE AT VENT HOLE AT TOP OF DIKE.
2. CENTER LINER VENT OVER VENT MATERIAL STRIP.
3. INSERT VENT MATERIAL IN VENT POCKET TO ASSURE AIR PASSAGE.

4/11 VENT PIPE DETAIL
NOT TO SCALE



GENERAL NOTES:
1. EMBANKMENT TO BE CONSTRUCTED & COMPACTED AS SPECIFIED IN SECTION 02300 – EARTHWORK.

2/11 SOUTH STORMWATER POND EMBANKMENT
NOT TO SCALE



5/11 POND STAGE GAUGES
NOT TO SCALE

NO.	REVISION DESCRIPTION	BY	DATE

PROJECT: 1-20165
DESIGNED: REC / BAA
DRAWN: BAA
CHECKED: REC
APPROVED: REC
DATE: JULY 7, 2020

7-7-2020

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PETERSON RANCH
BUFFALO CANYON FEEDERS, LLC CAFO
STORMWATER POND DETAILS

SHEET NO.
11
OF 12

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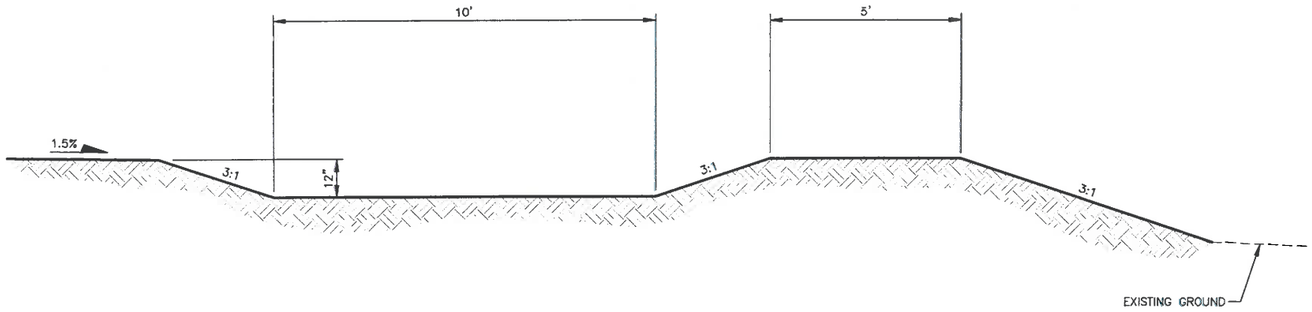
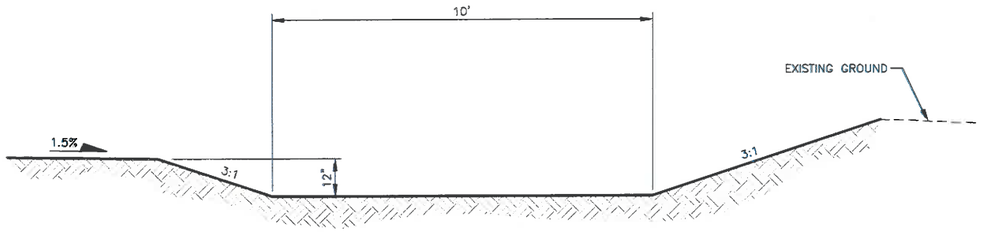
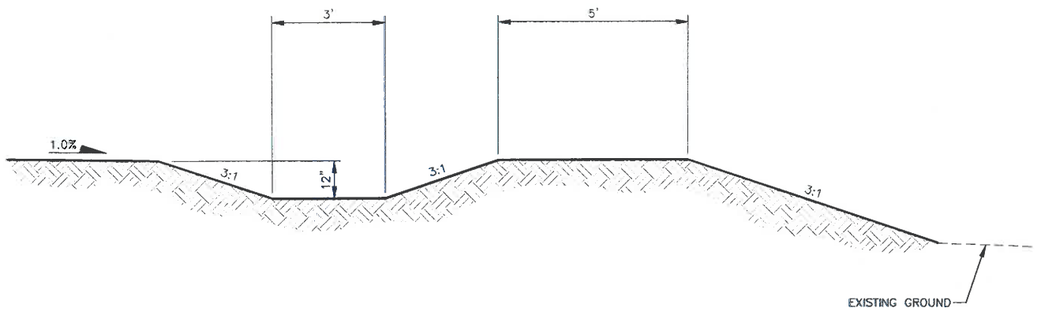


FILL AREA

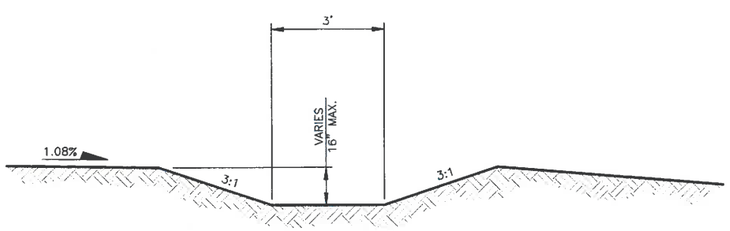


CUT AREA

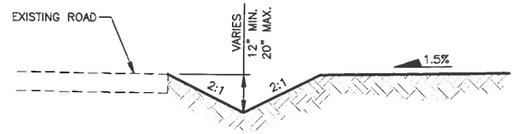
1/12 TYPE 1 DRAINAGE CHANNEL SECTION
NOT TO SCALE



2/12 TYPE 2 DRAINAGE CHANNEL SECTION
NOT TO SCALE



3/12 TYPE 3 DRAINAGE CHANNEL SECTION
NOT TO SCALE



4/12 TYPE 4 DRAINAGE V-DITCH SECTION
NOT TO SCALE

5/12 TYPE 5 DRAINAGE V-DITCH SECTION
NOT TO SCALE

NO.	REVISION DESCRIPTION	BY	DATE

PROJECT: 1-20165
DESIGNED: REC / BAA
DRAWN: BAA
CHECKED: REC
APPROVED: REC
DATE: JULY 7, 2020

ROBERT E. CHURCH 9707PE REGISTERED PROFESSIONAL ENGINEER STATE OF MONTANA 7-7-2020

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PETERSON RANCH
BUFFALO CANYON FEEDERS, LLC CAFO
DETAILS

SHEET NO.
12
OF 12

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Attachment D
Well Logs

MONTANA WELL LOG REPORT

This well log reports the activities of a licensed Montana well driller, serves as the official record of work done within the borehole and casing, and describes the amount of water encountered. This report is compiled electronically from the contents of the Ground Water Information Center (GWIC) database for this site. Acquiring water rights is the well owner's responsibility and is NOT accomplished by the filing of this report.

Other Options

Return to menu
Plot this site in State Library Digital Atlas
Plot this site in Google Maps
View hydrograph for this site
View field visits for this site
View water quality for this site
View scanned update/correction (9/28/2012 12:06:03 PM)

Site Name: PETERSON, JIM
GWIC Id: 266587
DNRC Water Right: 30063553

Section 1: Well Owner(s)

1) PETERSON, JIM (MAIL)
PO BOX 115
BUFFALO MT 59418 [04/15/2012]

Section 2: Location

Township	Range	Section	Quarter Sections
12N	15E	2	NE¼ NE¼ SE¼

County	Geocode
FERGUS	

Latitude	Longitude	Geomethod	Datum
46.829638	-109.79052	DIGITALMAP	WGS84

Ground Surface Altitude	Ground Surface Method	Datum	Date
4245.36	DEM	NAVD88	4/7/2020

Measuring Point Altitude	MP Method	Datum	Date Applies
4239.36	DEM	NAVD88	11/7/2012 5:00:00 PM

Addition	Block	Lot

Section 3: Proposed Use of Water

STOCKWATER (1)
DOMESTIC (2)

Section 4: Type of Work

Drilling Method: CABLE TOOL
Status: NEW WELL

Section 5: Well Completion Date

Date well completed: Sunday, April 15, 2012

Section 6: Well Construction Details

Borehole dimensions

From	To	Diameter
0	35	10.8
35	1909	6.3
1909	2003	4

Casing

From	To	Diameter	Wall Thickness	Pressure Rating	Joint	Type
2	35	7	0.375		THREADED	A53B STEEL
3	1909	4	0.375		THREADED	A53B STEEL
1880	2003	2.5	0.375		THREADED	A53B STEEL

Completion (Perf/Screen)

From	To	Diameter	# of Openings	Size of Openings	Description
1950	2000	8	75	1/4" X 8"	TORCH OR PLASMA CUTS

Annular Space (Seal/Grout/Packer)

From	To	Description	Cont. Fed?
0	35	CEMENT	
0	1909	CEMENT	

Section 7: Well Test Data

Total Depth: 2003
Static Water Level: 115
Water Temperature:

Artesian/Flow Test *

35 gpm for 72 hours.
Flow controlled by VALVES.

** During the well test the discharge rate shall be as uniform as possible. This rate may or may not be the sustainable yield of the well. Sustainable yield does not include the reservoir of the well casing.*

Section 8: Remarks

FLOWING ARTESIAN FLOW CONTROLLED BY FLOWING WELL PITLESS ADAPTER

Section 9: Well Log

Geologic Source

217KOTN - KOOTENAI FORMATION

From	To	Description
0	1	TOP SOIL
1	12	GRAVEL & SAND
12	15	TAN CLAY
15	720	GRAY SHALE WITH BENTONITE STRINGERS
720	1506	SHALE DARK GRAY GRITTY TO SILTY AND SANDY WITH LIGHT GRAY SANDSTONE STRINGERS & BENTONITE
1506	1530	LIGHT GRAY SILTSTONE WITH BLACK CHERT
1530	1902	DARK GRAY SHALE BRICK RED SHALE MAROON & PINK SHALE WITH SOME SANDSTONE LAYERS & LIMESTONE LAYERS
1902	1950	SANDSTONE CEMENTED FINE GRAIN TITE
1950	2000	AS ABOVE WITH SOME FRACTURED SALT & PEPPER SANDSTONE
2000	2003	RED SHALE & COAL

Driller Certification

All work performed and reported in this well log is in compliance with the Montana well construction standards. This report is true to the best of my knowledge.

Name: MARK A. SMITH
Company: CENTRAL DRILLING INC
License No: WWC-581
Date Completed: 4/15/2012

MONTANA WELL LOG REPORT

This well log reports the activities of a licensed Montana well driller, serves as the official record of work done within the borehole and casing, and describes the amount of water encountered. This report is compiled electronically from the contents of the Ground Water Information Center (GWIC) database for this site. Acquiring water rights is the well owner's responsibility and is NOT accomplished by the filing of this report.

Other Options

Return to menu
Plot this site in State Library Digital Atlas
Plot this site in Google Maps
View scanned well log (2/8/2007 10:27:53 AM)
View scanned update/correction (8/17/2010 10:49:14 AM)

Site Name: PETERSON JIM
GWIC Id: 177767
DNRC Water Right: 30048402

Section 1: Well Owner(s)

1) PETERSON, JIM (MAIL)
RR 1 BOX 116
BUFFALO MT 59418 [08/21/1998]

Section 2: Location

Township	Range	Section	Quarter Sections
12N	15E	1	NW¼ NW¼ SW¼

County: FERGUS
Geocode:

Latitude	Longitude	Geomethod	Datum
46.829776	-109.787132	TRS-SEC	NAD83

Ground Surface Altitude:
Ground Surface Method:
Datum:
Date:

Addition:
Block:
Lot:

Section 3: Proposed Use of Water

DOMESTIC (1)
STOCKWATER (2)

Section 4: Type of Work

Drilling Method: ROTARY
Status: NEW WELL

Section 5: Well Completion Date

Date well completed: Friday, August 21, 1998

Section 6: Well Construction Details

Borehole dimensions

From	To	Diameter
0	165	5

Casing

From	To	Diameter	Wall Thickness	Pressure Rating	Joint	Type
-2	23	6				STEEL
10	165	4				PLASTIC

Completion (Perf/Screen)

From	To	Diameter	# of Openings	Size of Openings	Description
55	100	4			SLOTS

Annular Space (Seal/Grout/Packer)

From	To	Description	Cont. Fed?
0	23	BENTONITE	

Section 7: Well Test Data

Total Depth: 165
Static Water Level: 8
Water Temperature:

Air Test *

8 gpm with drill stem set at _ feet for 2 hours.
Time of recovery 2 hours.
Recovery water level 8 feet.
Pumping water level 100 feet.

** During the well test the discharge rate shall be as uniform as possible. This rate may or may not be the sustainable yield of the well. Sustainable yield does not include the reservoir of the well casing.*

Section 8: Remarks

Section 9: Well Log

Geologic Source
Unassigned

From	To	Description
0	12	DIRTY GRAVEL
12	20	BROWN CLAY
20	21	HARD WHITE CHERT
21	50	GRAY SHALE WITH A FEW SANDSTONE LAYERS 1-3IN THICK
50	55	GRAY SHALE
55	100	HARDER FRACTURED GRAY SHALE WITH SOME CLAY LAYERS WATER
100	165	GRAY SHALE MED HARD

Driller Certification

All work performed and reported in this well log is in compliance with the Montana well construction standards. This report is true to the best of my knowledge.

Name: MARK A. SMITH
Company: CENTRAL DRILLING INC
License No: WWC-581
Date Completed: 8/21/1998

~~045~~ 12N 15E 02 DA JUDITH Basin

Form ~~WR-3~~ 603-R2/81 15N 13E File No. _____

WELL LOG REPORT CODED

State law requires that this form be filed by the water well driller within 60 days after completio 007860

RECEIVED
AUG 30 1982
MONT. DEPT. OF NATURAL RESOURCES & CONSERVATION

1. WELL OWNER
Name Ralph Lee

2. CURRENT MAILING ADDRESS
Buffalo Montana

3. WELL LOCATION
County ~~Broadwater~~ Judith Basin
Township 12 N/~~S~~ Range 15 E/W
¼ NE ¼ SE ¼ Section 2
Lot _____ Block _____
Subdivision _____

4. PROPOSED USE Domestic ☒ Stock ☐ Irrigation ☐
Other ☐ specify _____

5. DRILLING METHOD x cable, _____ bored, _____ forward rotary, _____ reverse rotary, _____ jetted, _____ other (specify) _____

6. WELL CONSTRUCTION AND COMPLETION

Size of drilled hole	Size and weight of casing	From (feet)	To (feet)	Perforations / Screen	Kind	Size	From (feet)	To (feet)
6"	6" steel ¼" wall	0	22	x		1/8" slots	16	18
6"	4" pvc 160psi	20	60					

Was casing left open end? x Yes ___ No
Was a packer or seal used? x Yes ___ No
If so, what material rubber
Was the well gravel packed? ___ Yes x No
Was the well grouted? x Yes ___ No
To what depth? between 4" & 6" casing
Material used in grouting cement
Well head completion: Pitless adapter ___ Yes ___ No
Top of casing 12 in. or greater above grade x Yes ___ No

7. WHAT IS THE TEMPERATURE OF THE WATER?
_____ Degrees Fahrenheit
☐ Measured ☐ Estimated

8. WATER LEVEL
Static water level 15 feet below land surface
If flowing; closed-in pressure _____ psi
_____ gpm
Controlled by: _____ valve, _____ reducers, _____ other, (specify) _____

9. WELL TEST DATA _____ pump x bailer _____ other, (specify) _____
Pumping level below land surface:
60 ft. after 1 hrs. pumping 7 gpm
_____ ft. after _____ hrs. pumping _____ gpm

10. WAS WELL PLUGGED OR ABANDONED? ___ Yes x No
If yes, how? _____

11. DATE COMPLETED 7/22/82

12. WELL LOG

Depth (ft.) From	To	Formation
0	7	topsoil & sandy clay
7	15	dirty gravel
15	17	gravel & sand
17	60	blue shale drilled for storage

(use separate sheet if necessary)

13. DRILLER'S CERTIFICATION
This well was drilled under my jurisdiction and this report is true to the best of my knowledge.

8/8/82
Date

DeBuff Drilling Co.
Firm Name

Gilt Edge Rte. Lewistown, Mt.
Address

_____
Signature

346
License No.

MONTANA DEPARTMENT OF NATURAL RESOURCES & CONSERVATION
32 SOUTH EWING HELENA, MONTANA 59620 449-3962 **DNRC**

artcraft printers of missoula

DEPARTMENT COPY

24415

Attachment E
Environmental Analysis

TECHNICAL MEMORANDUM

Buffalo Concentrated Animal Feeding Operation (CAFO) Site Footprint Environmental Analysis

PREPARED FOR:	Youderian Construction, Inc.
PREPARED BY:	Amy Chadwick and Jonathan Weaver
REVIEWED BY:	Bob Church
DATE:	April 27, 2020
PROJECT NUMBER:	1-20165
REVISION NO.:	0

Floodplains

Dry Creek flows north to south and is situated approximately 700 feet east proposed site. Mud Creek also flows north to south and is located approximately 2,000 feet to the west of the proposed site. Mud Creek and Dry Creek join approximately 3,500 feet to the north and form Ross Fork Creek. Refer to Figure 1.

Peak flows for both creeks were calculated by using the USGS web-based program StreamStats. The program used regional regression equations for the Upper-Yellowstone Central Mountain Region. Resulting drainage areas and peak flows are shown below in Table 1.

Table 1: Peak Flows for Dry Creek and Mud Creek

Flood Statistic in percent annual chance (AC) and recurrence interval	Peak Flows (cfs)	
	Dry Creek DA = 89.2 mi^2	Mud Creek DA = 28.4 mi^2
50% AC (2-year)	227	94.3
10% AC (10-year)	1,070	452
4% AC (25-year)	1,820	776
2% AC (50-year)	2,500	1,080
1% AC (100-year)	3,250	1,410
0.2% AC (500-year)	5,390	2,380

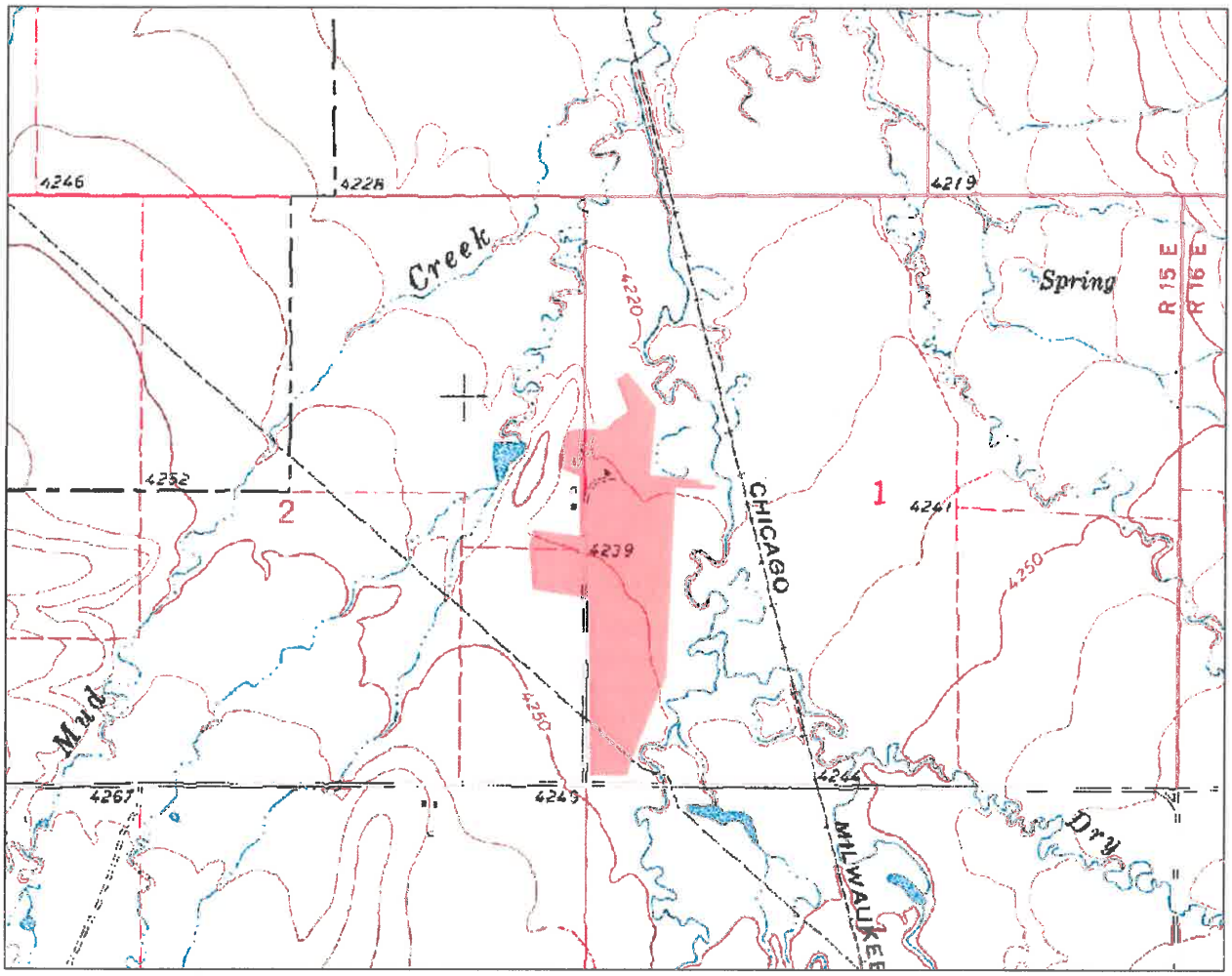


Figure 1: Site layout and USGS 24k Topographic Map

The proposed site layout is not within a Special Flood Hazard Area (SFHA) designated by the Federal Emergency Management Area (FEMA). FEMA has identified floodplains for other communities in Fergus County, but there are no designates areas near Buffalo, MT. Refer to Figure 2, below.

Figure 2: View of project site and FEMA's floodplain website

We reviewed the elevations from the survey completed by the client. It varies across the site, but there appears to be approximately 15 feet of elevation relief from the building sites down to Dry Creek. The northeast corner of the site is approximately 7 feet lower in elevation than the rest of the development and is therefore more susceptible to flooding from Dry Creek. The survey stopped on the west side of Dry Creek, so actual elevations at Dry Creek and east of Dry Creek are unknown.

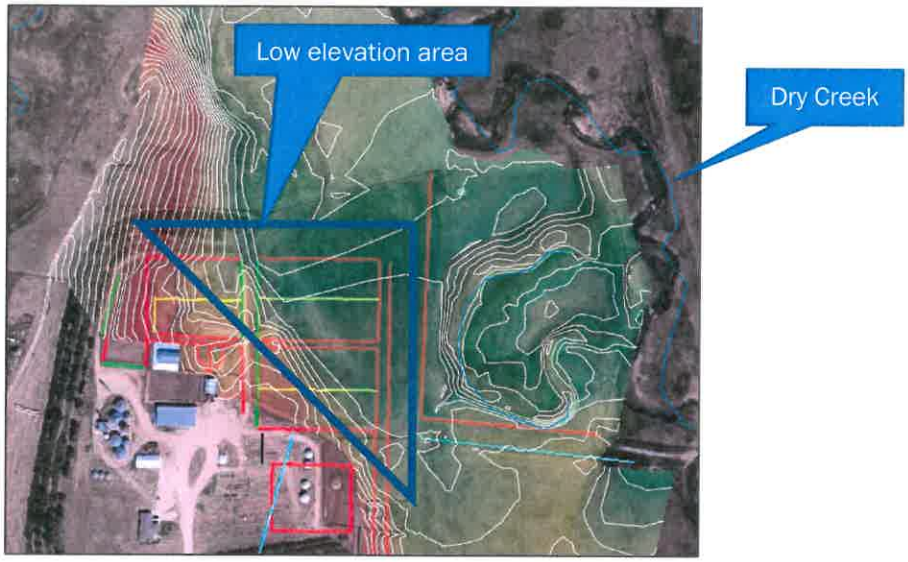


Figure 3: Low elevation area at northeast corner

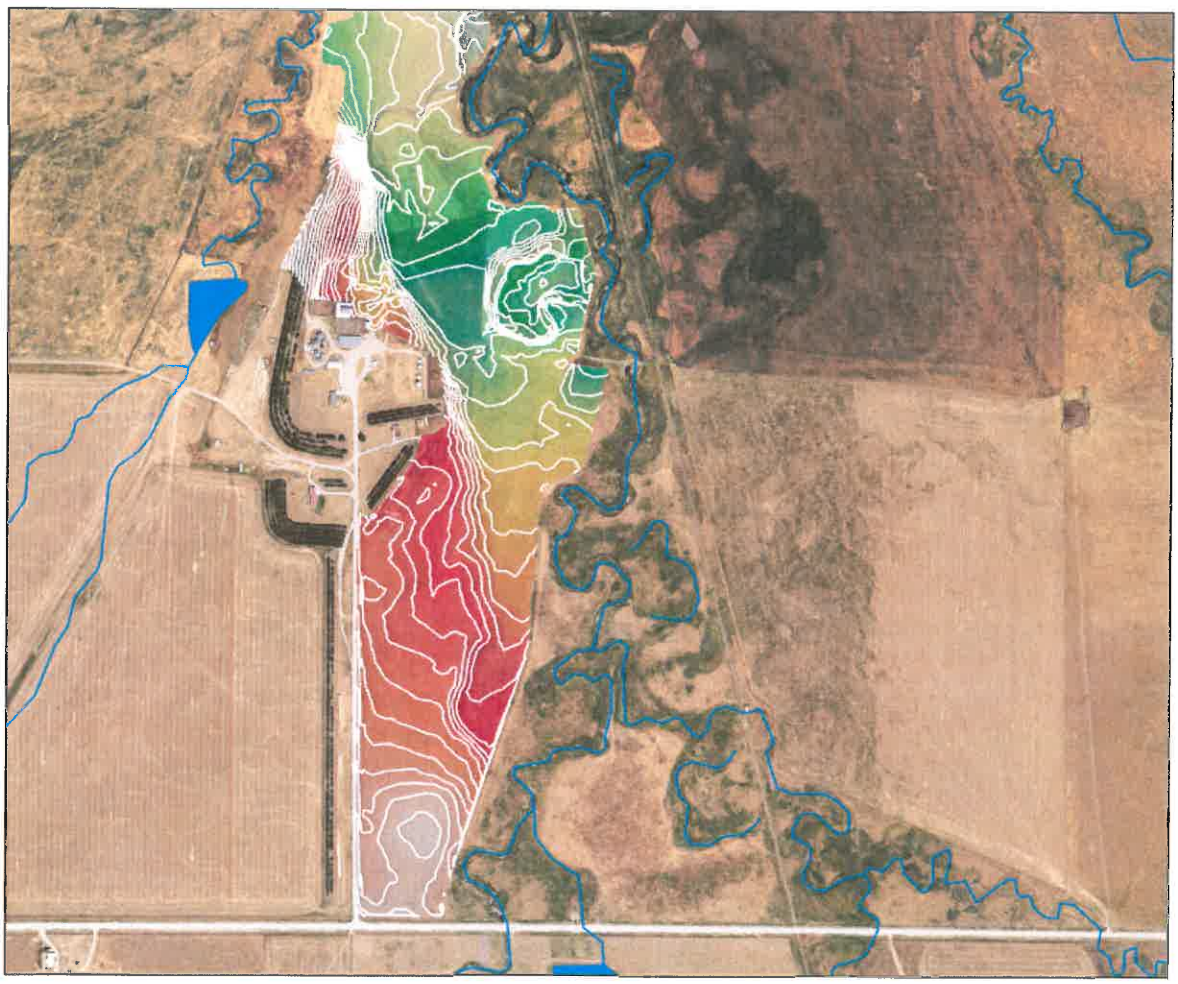


Figure 4: Site layout with contours and shaded relief

Even though FEMA has not studied this area to determine flood risk, the proposed site could be within a 100-year floodplain. A hydraulic model could be used to determine water surface elevations of Mud Creek and Dry Creek.

Wetlands

The proposed design layout does not encroach on any wetlands mapped in the public National Wetland Inventory/Montana Natural Heritage Program (MNHP) wetland mapping dataset, with the possible exception of a small linear palustrine emergent (PEMC) wetland at the northern edge of the project extent (See Figures 5 and 6). The proposed design avoids the oxbow at the northeast boundary of the project extent and the channel of Ross Fork Creek east of the project extent. The final design would need to protect any unmapped wetlands in the oxbow channel and preventing wastewater from entering the oxbow area.

Figure 5. Generalized CAFO project extent (orange outline). Final design has not been developed.

The MNHP wetlands data in Figure 6 only represent wetlands mapped by interpretation of aerial imagery and should not be considered a definitive inventory of wetlands in the project area. Additional wetlands, not yet mapped, may occur within the proposed design limits. A field-based wetland/aquatic resource survey will likely be required for project permitting. Wetlands near the project are associated with Ross Fork Creek active and its overflow or abandoned channels.

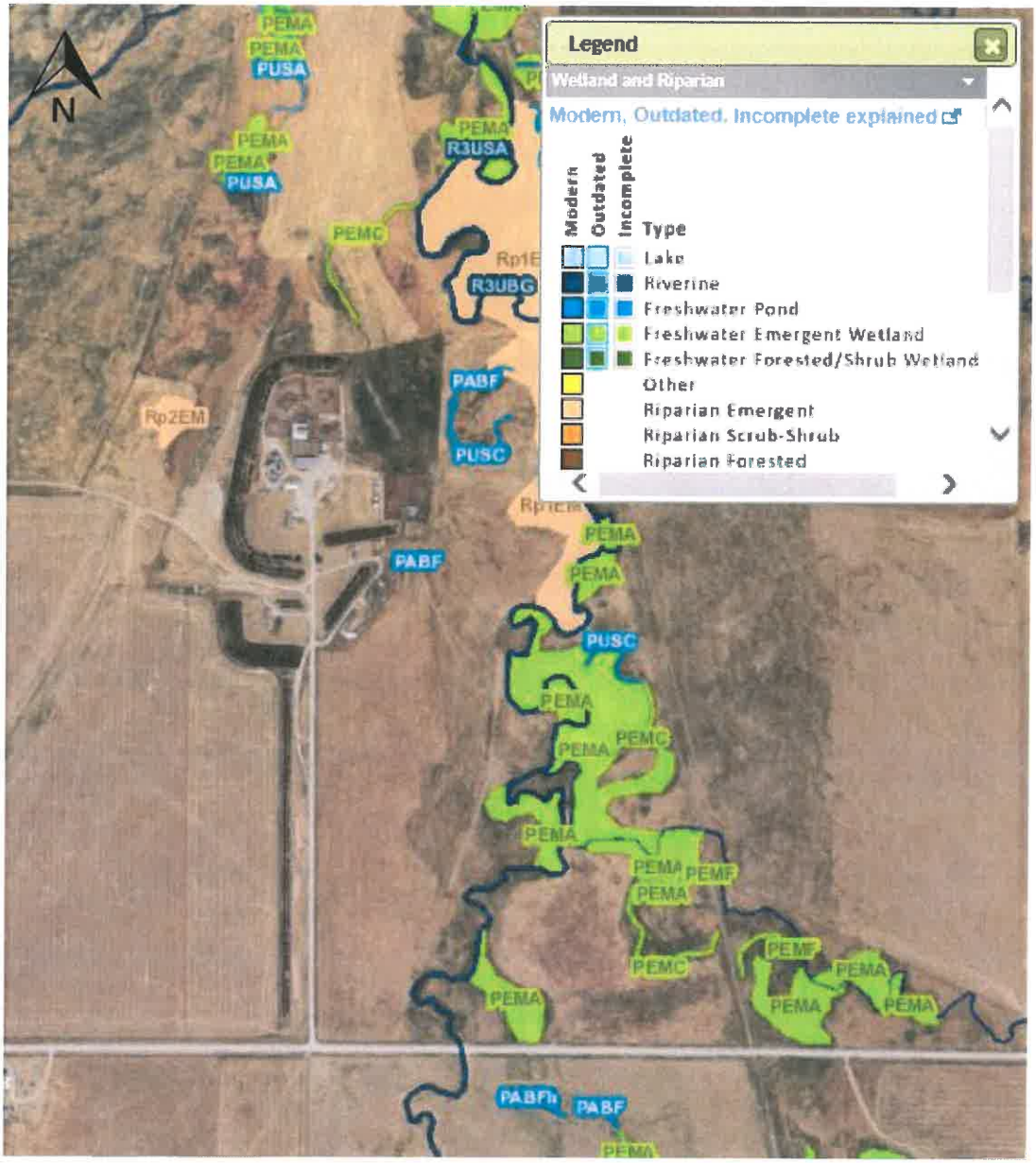


Figure 6. Mapped wetlands near the proposed project extent

Groundwater

The cells at the northeast corner of the proposed project limit would extend into an area likely prone to groundwater pooling and/or surface water flooding. The 2009 aerial image shows evidence of water pooling and ground scour, potentially from runoff at the northeast corner of the project (Fig. 7). The proposed design will need to account for and mitigate risk to groundwater in this area.

Figure 7. Aerial image from 2009 shows standing water and signs of scour on floodplain (yellow arrow).

The area in the northeast corner of the project limit appears not to be consistently wet or inundated, based on the history of cultivation (Fig. 8). A linear depression, where water is pooled Figure 7 is evident within the cultivated area, and historically may have been a side channel or overflow channel.

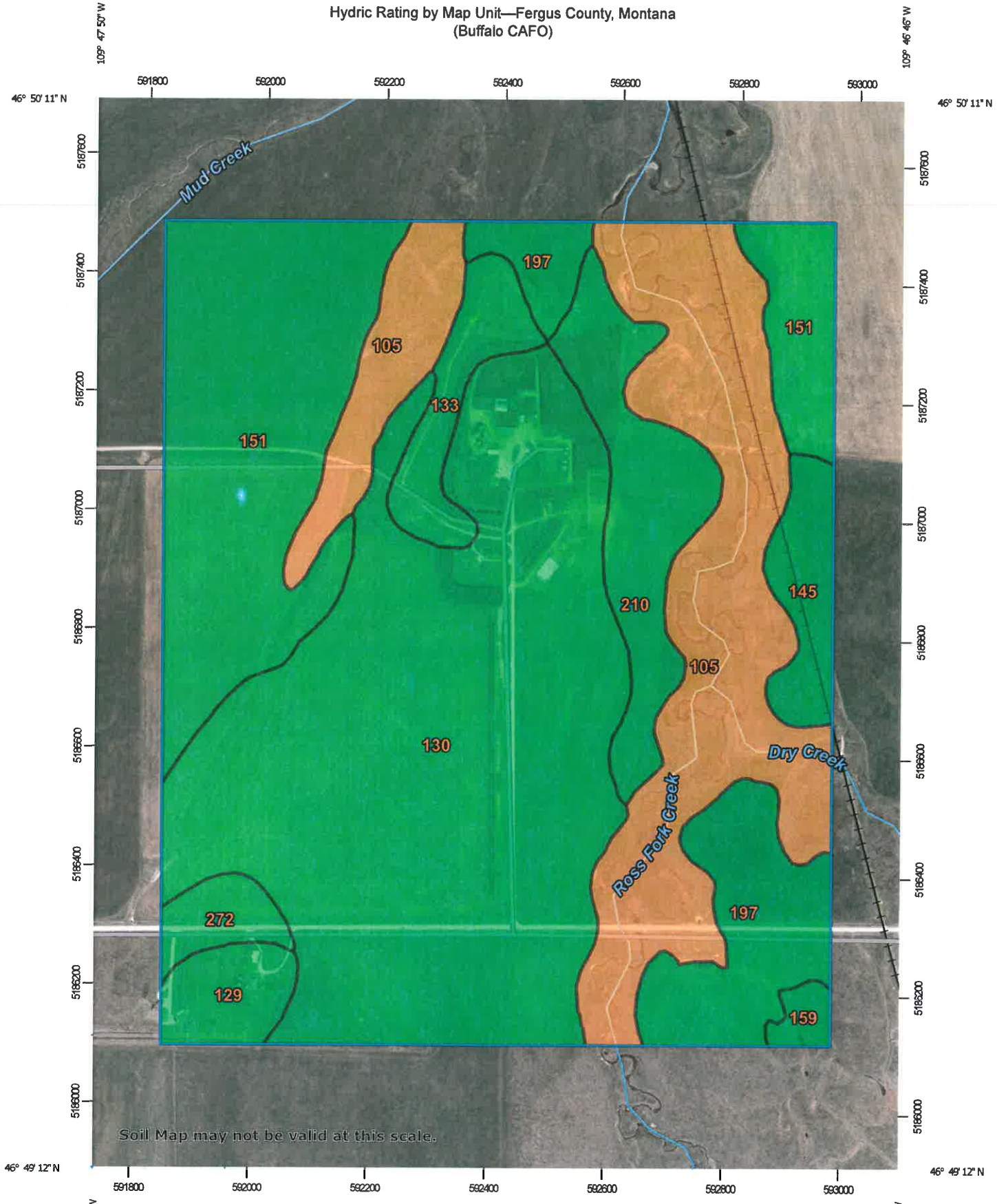
Figure 8. Aerial photos from 2004 (left) and 2013 (right) show history of cultivation around historic side channel (potential high groundwater area) at northeast corner of proposed CAFO project.

Soils in the cultivated area at the northeast corner of the project are not considered hydric in the Natural Resources and Conservation (NRCS) soil data, indicating the majority of soils in this area are not likely saturated for greater than two weeks during the growing season. A soil map of the project area is attached as **Appendix A**. Areas lacking hydric soils may still be subject to seasonal high groundwater or surface runoff.

APPENDIX A

HYDRIC SOILS

Hydric Rating by Map Unit—Fergus County, Montana
(Buffalo CAFO)



Map Scale: 1:8,780 if printed on A portrait (8.5" x 11") sheet.

N

Meters: 0 100 200 400 600

Feet: 0 400 800 1600 2400

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 12N WGS84

MAP LEGEND

Area of Interest (AOI)
- Area of Interest (AOI)

Soils

Soil Rating Polygons
- Hydric (100%)
- Hydric (66 to 99%)
- Hydric (33 to 65%)
- Hydric (1 to 32%)
- Not Hydric (0%)
- Not rated or not available

Soil Rating Lines
- Hydric (100%)
- Hydric (66 to 99%)
- Hydric (33 to 65%)
- Hydric (1 to 32%)
- Not Hydric (0%)
- Not rated or not available

Soil Rating Points
- Hydric (100%)
- Hydric (66 to 99%)
- Hydric (33 to 65%)
- Hydric (1 to 32%)
- Not Hydric (0%)
- Not rated or not available

Water Features
- Streams and Canals

Transportation
- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

Background
- Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:24,000.

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Fergus County, Montana
Survey Area Data: Version 20, Sep 16, 2019

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Aug 28, 2014—Nov 7, 2016

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Hydric Rating by Map Unit

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
105	Fluvaquentic Haplaquolls, nearly level	90	80.9	20.7%
129	Judith-Judell clay loams, 2 to 4 percent slopes	0	8.4	2.2%
130	Judith-Tamaneen clay loams, 0 to 2 percent slopes	0	147.4	37.7%
133	Judith-Windham gravelly clay loams, 2 to 8 percent slopes	0	11.4	2.9%
145	Lawther silty clay, 0 to 2 percent slopes	0	10.3	2.6%
151	Linwell silty clay loam, 0 to 2 percent slopes	0	72.0	18.4%
159	Marcott silty clay loam	0	2.4	0.6%
197	Savage silty clay loam, 0 to 2 percent slopes	0	27.8	7.1%
210	Straw clay loam, 0 to 2 percent slopes	0	24.4	6.2%
272	Winifred-Judith clay loams, 4 to 8 percent slopes	0	5.8	1.5%
Totals for Area of Interest			**390.7**	**100.0%**

Description

This rating indicates the percentage of map units that meets the criteria for hydric soils. Map units are composed of one or more map unit components or soil types, each of which is rated as hydric soil or not hydric. Map units that are made up dominantly of hydric soils may have small areas of minor nonhydric components in the higher positions on the landform, and map units that are made up dominantly of nonhydric soils may have small areas of minor hydric components in the lower positions on the landform. Each map unit is rated based on its respective components and the percentage of each component within the map unit.

The thematic map is color coded based on the composition of hydric components. The five color classes are separated as 100 percent hydric components, 66 to 99 percent hydric components, 33 to 65 percent hydric components, 1 to 32 percent hydric components, and less than one percent hydric components.

In Web Soil Survey, the Summary by Map Unit table that is displayed below the map pane contains a column named 'Rating'. In this column the percentage of each map unit that is classified as hydric is displayed.

Hydric soils are defined by the National Technical Committee for Hydric Soils (NTCHS) as soils that formed under conditions of saturation, flooding, or ponding long enough during the growing season to develop anaerobic conditions in the upper part (Federal Register, 1994). Under natural conditions, these soils are either saturated or inundated long enough during the growing season to support the growth and reproduction of hydrophytic vegetation.

The NTCHS definition identifies general soil properties that are associated with wetness. In order to determine whether a specific soil is a hydric soil or nonhydric soil, however, more specific information, such as information about the depth and duration of the water table, is needed. Thus, criteria that identify those estimated soil properties unique to hydric soils have been established (Federal Register, 2002). These criteria are used to identify map unit components that normally are associated with wetlands. The criteria used are selected estimated soil properties that are described in "Soil Taxonomy" (Soil Survey Staff, 1999) and "Keys to Soil Taxonomy" (Soil Survey Staff, 2006) and in the "Soil Survey Manual" (Soil Survey Division Staff, 1993).

If soils are wet enough for a long enough period of time to be considered hydric, they should exhibit certain properties that can be easily observed in the field. These visible properties are indicators of hydric soils. The indicators used to make onsite determinations of hydric soils are specified in "Field Indicators of Hydric Soils in the United States" (Hurt and Vasilas, 2006).

References:

Federal Register. July 13, 1994. Changes in hydric soils of the United States.

Federal Register. September 18, 2002. Hydric soils of the United States.

Hurt, G.W., and L.M. Vasilas, editors. Version 6.0, 2006. Field indicators of hydric soils in the United States.

Soil Survey Division Staff. 1993. Soil survey manual. Soil Conservation Service. U.S. Department of Agriculture Handbook 18.

Soil Survey Staff. 1999. Soil taxonomy: A basic system of soil classification for making and interpreting soil surveys. 2nd edition. Natural Resources Conservation Service. U.S. Department of Agriculture Handbook 436.

Soil Survey Staff. 2006. Keys to soil taxonomy. 10th edition. U.S. Department of Agriculture, Natural Resources Conservation Service.

Rating Options

Aggregation Method: Percent Present

Component Percent Cutoff: None Specified

Tie-break Rule: Lower